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ABSTRACT

The Program for Learning in Accordance with Needs (PLAN) is characterized by a completely individualized pattern of organization. It employs multiple textbooks and materials which cross grade level lines, subject matter area lines, and teacher-pupil lines. It places particular emphasis on a high concentration of modern mathematics content. The computer performs four major managerial functions, i.e., test scoring, diagnosis, prescribing, and reporting. Traditional or non-PLAN schools follow a class-as-a-whole or team teaching arrangement in which a single text book series is followed according to prescribed grade level lines with standardized concentration on modern mathematics content. Performance differences between PLAN and nonPLAN middle elementary grade mathematics students were analyzed on the basis of results obtained in the Otis Lennon Intelligence Test and the Metropolitan 1970 Standard Achievement Test, Intermediate Battery. The sample was drawn from a single district of a highly mobile, educationally disadvantaged population in a northern Illinois city during the 1972-73 school year. Overall, the non-PLAN schools did as well as or better than the PLAN schools. This may have been due to the high percentages of minority students, high percentages of low IQ students, and high student mobility in PLAN schools. (Author/JM)

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THE EFFECTIVENESS OF AN INDIVIDUALLY-ORGANIZED, COMPUTER-MANAGED PROGRAM (PLAN) WITH EDUCATIONALLY DISADVANTAGED STUDENTS IN MIDDLE ELEMENTARY GRADE MATHEMATICS

A dissertation submitted in partial
fulfillment of the requirements for
the degree of

DOCTOR OF PHILOSOPHY

to the graduate faculty of
NATIONAL COLLEGE
and GRADUATE SCHOOL

U.S. DEPARTMENT OF HEALTH,
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by

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Submitted	Approved
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FORWARD

Today, almost 17 years after the event of Sputnik, the repercussive effects of unprecedented change in American public education are still being felt in the elementary schools and particularly in their mathematics programs. Coming late (1969) as it has on the scene of the change, the computer as an aid to the management of instruction (as is true of the PLAN system) has inherited some solutions (old and new) and some problems (old and new) in the never-ending search for a versatile yet sound instructional mathematics program which is suited to all students and to the time and the society in which they live.

In the present study two comparisons are drawn: One between the effectiveness of mathematics programs in two PLAN schools and another between programs of these two schools and a larger sample of traditional schools in the same district. In the first case the programs are identical, and the pupils are quite similar in IQ pattern so that the only major differences are in the length of times the PLAN program has been in operation, class size, and size of the samples. The 1972-73 school year (the year from which all the data was drawn) was the third year of operation under the PLAN system for PLAN school I and the second year of operation for PLAN school II. The total number of subjects enrolled was 230 for PLAN school I and 157 for PLAN school II. Both groups contained a high percentage of low and middle range IQ subjects and high percentages of minority groups. There was no significant difference in overall mean IQ between the two PLAN schools in grades 4 and 5 but a significant difference in mean IQ did appear between the two in grade 6, with PLAN school II students testing significantly higher.

In comparing the PLAN system with that of traditional schools, the following major distinctions might be noted: PLAN is characterized by a completely individualized pattern of organization. It employs multiple textbooks and materials which cross grade level lines, subject matter area lines, and teacher-pupil lines. It places particular emphasis on a high concentration of modern mathematics content. The computer performs four major managerial functions, i.e. test scoring, diagnosis (based on considerable teacher input), prescribing (also based on considerable teacher input), and reporting under a pre-test, prescription, post-test arrangement.

Traditional or Non-PLAN schools in the district follow a class-as-a-whole or team teaching arrangement in which a single textbook series is followed according to prescribed grade level lines with standardized concentration on modern mathematics content. The computer is not used in these schools.

Non-PLAN students showed significantly higher IQ scores than did PLAN school students throughout the three grades in this ex post facto study.

Some brief comments may be in order concerning the results. One of the two PLAN schools (PLAN school II) compared more favorably with the traditional schools than did the other in the performance tests. The teacher variable and smaller class size are believed to be the key factors in this finding.

Since traditional school students earned significantly higher IQ scores than did PLAN students in all three grades, the data most useful in comparing PLAN with Non-PLAN performance was the scores which had been arranged according to high, medium, and low IQ subjects. Under this arrangement the following results appeared:

1. Traditional schools were often more effective than PLAN schools in the Computation subtests. (Significantly higher scores were earned in six out of nine possible cases.)
2. PLAN was consistently equally effective with Non-PLAN in Problem Solving (eight out of nine possible cases).
3. Effectiveness in Concepts was divided between PLAN and Non-PLAN groups with PLAN II testing higher in one case and Non-PLAN groups testing significantly higher in three cases. In the remaining five Concepts tests, PLAN and Non-PLAN were equally effective.

The factors which are believed to have influenced these findings are as follows:

1. In the PLAN curriculum greater emphasis is placed on independent thinking and problem solving than upon practice and drill.
2. Greater emphasis is placed on modern mathematics content in the PLAN curriculum than is true in the traditional schools. (Much of the modern mathematics content covered in PLAN is not tested in Metropolitan '70.)

In grade level comparisons PLAN appeared to be more competitive with traditional schools in grades 4 and 5 and less effective than traditional schools in grade 6. It is barely possible that the high concentration of modern mathematics topics (61%) in the units from which sixth grade prescriptions are drawn may have influenced these results. The extent to which modern mathematics topics were actually selected, however, is not known.

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ABSTRACT

Performance differences between PLAN and Non-PLAN middle elementary grade mathematics students were analyzed on the basis of results obtained in the Otis-Lennon Intelligence Test and the Metropolitan '70 Standard Achievement Test, Intermediate Battery.

The sample was drawn from a single district of a highly mobile, educationally disadvantaged population in a midwestern city during the 1972-73 school year.

Two major comparisons were drawn: One between students in the two individualized (PLAN) schools, and one between PLAN and Non-PLAN students in the same district.

Of the two individualized schools, the school having the smaller sized classes (PLAN school II) proved to be more effective.

Initial analysis of PLAN, Non-PLAN data revealed that the traditional school students in all three grades held significantly higher mean IQ scores than did PLAN school students. Performance scores were therefore next differentiated in terms of high, medium, and low IQ students. Under this arrangement the following conclusions were drawn:

1. Traditional schools were often more effective than PLAN schools in the Computation subtests. (Signifi-

cantly higher scores were earned in six out of nine possible cases.)

2. PLAN was consistently equally effective with Non-PLAN in Problem Solving (eight out of nine possible cases).

3. Effectiveness in Concepts was divided between PLAN and Non-PLAN groups with PLAN II testing higher in one case and Non-PLAN groups testing significantly higher in three cases. In the remaining five Concepts tests, PLAN and Non-PLAN were equally effective.

4. Grade level comparisons: With the exception of two Problem Solving subtests, Non-PLAN students tested significantly higher than PLAN in grade 6. With the exception of three Computation subtests, PLAN was equally or more effective than Non-PLAN in grades 4 and 5.

It is the belief of the present investigator that high percentages of minority students and high percentages of low IQ students in PLAN influenced the findings.

High mobility of the student population may also have had a detrimental effect on PLAN student performance due to the extended orientation experience required for newcomers to PLAN.

Chapter 1

BACKGROUND

Wilhelm[1] and Shanner[2] have said that individualized instruction has been a long sought but elusive goal of educators. Twenty years ago Brueckner and Grossnickle remarked that in arithmetic instruction in the elementary grades "The wide range in ability of pupils in any grade group shows that the traditional concept of 'grade' must be discarded. It violates all that we have learned about individual differences in any group of pupils."[3] These men advocated "a program of differentiated instruction adapted to the needs, interests, and abilities of the children."[4]

In the late 1950's and early 1960's the status of science and mathematics instruction in the United States was such that it was not competitive with that of other leading nations of the world community.

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[1] Fred T. Wilhelms, "The Curriculum and Individual Differences," Individualized Instruction, Sixty-first Yearbook of the National Society for the Study of Education (Chicago: University of Chicago Press, 1962).

[2] William M. Shanner, "PLAN, A System of Individualized Instruction Utilizing Currently Available Instructional Materials" (New York: Westinghouse Learning Corporation, 1968).

[3] Leo J. Brueckner and Foster E. Grossnickle, Making Arithmetic Meaningful (Philadelphia: The John C. Winston Co., 1953), p. 95.

[4] Ibid., p. 97.

Physical science professors found it necessary to teach mathematics to their science students before they could begin college level science instruction. Mathematics education had declined to a point where it was regarded by leading science-mathematics educators as a national emergency.[5] Curricular guidelines, standardized textbooks, and norm-centered standardized tests had contributed to the formation of a closed system which had grown unresponsive to changing times.

In the 1960's and beyond, pressure for updating programs brought marked change in three directions, i.e. (1) change in content from an arithmetical to a mathematical orientation, (2) change in gradation of topics, and (3) movement toward the individualizing of instruction by technological means. In the first two instances a point of stabilization is on point of being achieved,[6] whereas in the third instance programs for individualizing instruction are still in process of being generated and developed in terms of modern technology.

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[5] Personal communication with administrators of a National Science Foundation sponsored program at the University of Illinois, 1959.

[6] Foster E. Grossnickle and John Reckzeh, Discovering Meanings in Elementary School Mathematics, 6th edition (New York: Holt, Rinehart and Winston, Inc., 1973), preface and Chapter 1.

Programmed learning, the teaching machine, and computer-assisted instruction systems were the forerunners to the systems which concentrate on management aspects of individualized instruction or the computer-based instructional management systems. One such system, a Program for Learning in Accordance with Needs (PLAN)[7] is being followed in some of the schools in the school district that has been selected for the present study. The PLAN system utilizes curriculum objectives developed by other groups as well as textbooks and instructional materials currently in use in public and private schools. The computer makes the tutorial program manageable and in essence individualizes the program.

What has proved effective and what is currently being developed in PLAN and in other individualized programs could eventually lead to the kind of differentiated instruction which Brueckner and Grossnickle sought.

STATEMENT OF THE PROBLEM

Attainment of the broad goals of PLAN in which the student is to develop a sense of responsibility for his own educational, personal, and social

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[7] Westinghouse Learning Corporation, Palo Alto, California.

development[8] and to make decisions in these particulars while he is learning elementary school subjects constitutes indeed a large order. Obviously these goals cannot be measured in direct ways. What can be measured supplies only partial answers to one small segment of the question, but it is a beginning. What can be measured are the patterns of differences between the ways in which PLAN and Non-PLAN students perform when exposed to the same standardized test.

The question with which the present study is concerned is whether or not PLAN in its current stage of development and as presently practiced in a particular school district can in any way enhance performance of students in elementary school mathematics beyond that of students in traditionally organized programs that are being followed in the same district.

The problem stated in null hypothesis terms is as follows:

Performance by students in grades 4, 5, and 6 in District A who have followed PLAN in mathematics will not differ significantly from the performance of students in traditionally organized mathematics classes in grades 4, 5, and 6 in District A.

This hypothesis will be tested with PLAN students as a group and/or as separate sub groups compared to a control (traditional) group based on the mathematics test scores in the Metropolitan '70 Standard Achievement Tests, Intermediate Battery.

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[8] John C. Flanagan, "Functional Education for the Seventies," Phi Delta Kappan, September, 1967.

The present study is undertaken in the hope that it may shed new light on the contribution of the PLAN organization to the evolution of an effective program of individualization in elementary school mathematics instruction.

METHODOLOGY

Population

Scores were reported for approximately 1350 students in grades four through six from the public schools in a single school district (District A) in a northern Illinois city (City C).

Of this number, 963 students were enrolled in Non-PLAN schools, 230 were enrolled in School I (hereafter referred to as PLAN I), and 157 were enrolled in School II (hereafter referred to as PLAN II) in the 1972-1973 school year. In PLAN I the PLAN system had been in operation for three years, whereas in PLAN II 1972-1973 was its second year of operation.

City C has been divided into two large districts, District A and District B. District A (from which the experimental and control samples have been drawn) has an estimated population of 39,000[9] and contains the major portion of City C's industry. The majority of City C's non-white and Spanish-American people reside in District A so that non-whites comprise approximately 16 per cent and Spanish-Americans approximately 20 per cent of District A's population. The range of the socio-economic strata is from low-low to upper-middle class (according to U. S. Census Bureau 1970 reports). There is considerable mobility in the student population so that minority percentages vary from school to school and from year to year. The median annual income for District A is $10,000 as compared with $12,000 for City C.[10]

Instrumentation

Scores were derived from the intermediate battery of the Metropolitan '70 Standard Achievement Test and the Otis-Lennon Intelligence Test, both of which were administered in May of 1973.

Definition of Terms

The two major types of systems for computerized instruction are computer-assisted instruction (CAI) and computer-managed instruction (CMI). In the former system the student participates with the computer on a direct basis and the instructional materials are stored in the computer system.[11]

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[9] Department of Commerce, 1972.

[10] Ibid.

In the CMI system the computer is utilized to assist the teacher in guiding and administering the instructional process. Instructional materials are not stored in the computer system, and the student does not interface directly with the computer. The computer does not teach the student any of his instructional program.[12]

In PLAN's CMI system the computer stands behind the teacher as an informational aid. It records and stores the student's academic and learning history, furnishing it back to the teacher on a retrieval basis as needed. It scores tests and examinations and monitors the progress of the student on a day-to-day basis.[13]

The computer is concerned with the managerial, the non-instructional aspects of the program. Individualization applies to the assignments and methods of achieving them, and students may learn through group discussion, independent study, or by teacher-led activities.[14]

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[11] Harvey J. Brudner, "Computer-Managed Instruction," Individualizing Instruction in Science and Mathematics, ed. Virgil M. Howes (New York: The Macmillan Co., 1970), p. 156.

[12] Ibid., p. 157.

[13] Shanner, op. cit.

[14] Ibid.

Chapter 2

REVIEW OF THE LITERATURE

CURRICULAR AND STRUCTURAL CONSIDERATIONS AFFECTING MODERN PROGRAMS

Changes in Grade Placement of Arithmetic Content in the 1930's

The major changes that occurred in the arithmetic curriculum of the 1930's can be traced to the influence of one man--Carleton W. Washburne.

Washburne instituted an individualized program for all subjects in the elementary grade schools of Winnetka, Illinois. He was exuberant about this enterprise and wrote of it as follows:

> "Fifty-seven children (5 per cent of the enrolment) saved from grade repetition, over $5000 consequently saved to the Board of Education, and eighty-seven children saved from going into the next higher grade with a weak foundation in one or more subjects--these are three definitely measurable results of less than a year of individual instruction in the public schools of Winnetka, Illinois."[1]

In 1922 Washburne re-activated and chaired the Committee of Seven[2] a group which in some ways was to follow in the footsteps of the Conference on Mathematics[3] but making its recommendations on the basis of both local and wide-spread research programs which it launched.

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[1] Carleton W. Washburne, "The Individual System in Winnetka," Elementary School Journal, September, 1920, p. 52.

[2] This Committee of superintendents and principals had originally conducted discussions of various curricular problems in the northern Illinois area. In the 1920's and 1930's administrators from the University of Chicago elementary school, Wilmette schools, Batavia schools, the

The Committee of Seven brought about widespread and dramatic changes in arithmetic curriculum in the 30's, stirred a controversy,[4] organized some of its critics into the "meaning theory camp,"[5] and left an indelible record for research as a basis for change in educational practice.

Francis W. Parker School, and the Dolton schools took part as did the Head of the Department of Education of Northern Illinois State Teachers' College. See John L. Tewksbury, "An Historical Study of the Winnetka Public Schools from 1919 to 1941," Volumes I, II, III (unpublished Doctor's dissertation, Northwestern University, 1962), pp. 390, 391.

[3] The Conference on Mathematics was appointed by the "Committee of Ten," which in turn had been appointed by the National Education Association in Saratoga in 1892. (Charles W. Eliot, President of Harvard University, was the chairman of the Committee of Ten). The members of the Conference were unanimously of the opinion that a "radical" change in the teaching of arithmetic was necessary. Their principal recommendation was for "abridgement" (elimination of topics and examples "not easily made intelligible to the pupil"). See Frank H. Hall, Arithmetic; How to Teach It, a monograph (New York: Werner School Book Co., 1900) pp. 4-9.

[4] J. Murray Lee and Dorris May Lee, The Child and His Curriculum, 2nd edition (New York: Appleton-Century-Crofts, 1950), p. 456.

[5] William A. Brownell, "Psychological Considerations in the Learning and the Teaching of Arithmetic," The Teaching of Arithmetic, Tenth Yearbook of the National Council of Teachers of Mathematics (Washington, D. C.: NCTM, 1935), p. 19.

Its impact was perhaps best expressed by Brownell, one of its critics, when he said:

> "No other single research study or group of studies has, however, attracted the attention which has been accorded the reports of the Committee of Seven.... Its work has unquestionably affected practice widely but, I fear, not always wisely."[6]

The two areas in which the Committee of Seven influenced practice so widely were (1) in the drill or association (connectionist) method employed in the grade placement studies themselves and (2) in the conclusions of studies regarding grade placement and mental age and subsequent recommendations for postponement of topics.

In the former case, the extent to which drill and association psychology influenced the work can be traced through the pupil textbooks which Washburne developed for the Winnetka schools. In one sample book from this series, 95 of 108 pages were devoted to the development of computational skills.[7]

This practice came to dominate the theoretical and practical scenes in the 1930's. In the 29th Yearbook of the NSSE Brueckner remarked, "Under present conditions the computational function of number is considered to be its major objective." He cited a survey in which Steel found that 86% of the time devoted to arithmetic was used in presenting new processes of computation or in practice in working examples in new and previously taught processes.[8]

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[6] William A. Brownell, "A Critique of the Committee of Seven's Investigations on the Grade Placement of Arithmetic Topics," The Elementary School Journal, XXXVIII, March, 1938, p. 495.

[7] Carleton Washburne et al., Washburne Individual Arithmetic, Book Five (New York: World Book Co., 1927).

Other articles in the same yearbook bore the following titles: "Mixed Versus Isolated Drill Organization," "The Learning of the 100 Multiplication Combinations," and "The Grade Placement of Arithmetic Topics: A 'Committee of Seven' Investigation."[9]

In the case of postponement of topics, administrators were beset with problems of school failures which were caused by failures in arithmetic. They were eager to reduce both the number of failures and the attending dollar costs. They were eager to match Washburne's successes.

The Winnetka Plan was fashioned after Burke's maxim, i.e. "A year's work in a subject is what the slowest, normal, diligent child can accomplish in a year."[10] This then was to become the standard in the new standardized system.

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[8] Leo J. Brueckner, "A Critique of the Yearbook," Twenty-ninth Yearbook of the National Society for the Study of Education (Bloomington, Ill.: Public School Publishing Co., 1930), p. 687.

[9] Ibid., Chapters VI, VII, and XIII.

[10] Carleton W. Washburne and Sidney P. Marland, Jr. Winnetka--The History & Significance of an Educational Experiment (Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1963), p. 23.

Dramatic changes were made in the structure of textbooks across the country. The "Stepped-Up" curriculum was introduced and items and topics were postponed a semester, a year, or more in order that these topics or items might be taught at mental ages indicated by the Committee of Seven studies.[11]

The following exerpts from the Preface of each of four middle elementary grade textbooks in a "Stepped-Up" edition of one publisher's series[12] reflect specific patterns of postponement which ensued.

Grade 3

1) Number areas including the facts with products and dividends from 40 through 81 have been stepped-up to Grade Four.

2) Teaching of carrying in multiplication from ten's place and from both one's place and ten's place has been stepped-up to Grade Four.

3) All carrying in division has been postponed until Grade Four.

4) Teaching of remainders in division has been expanded and is presented in long division form.

5) Additional practice in the more difficult third-grade skills has been introduced to replace the skills stepped-up to Grade Four.

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[11] C. W. Hunnicutt and W. J. Iverson, editors, Research in the Three R's (New York: Harper and Brothers, 1958), pp. 373-374.

[12] Joseph C. Brown et al., Champion Arithmetics, Stepped-Up edition (Evanston, Ill.: Row, Peterson & Co., 1937).

Grade 4

1) Long division of whole numbers has been stepped-up to Grade Five.

2) Addition and subtraction of common fractions have been deferred until Grade Five.

3) All work involving computation in finding area has been deferred until Grade Six.

4) Multiplication of whole numbers with two- and three-figure multipliers has been moved from the first half to the second half of Grade Four.

5) Fractions in the quotient, indicating a completed division, have been moved from the first half to the second half of Grade Four.

6) All the difficult skills in addition, subtraction, multiplication, and division of whole numbers, which were presented in Grade Three, have been retaught in Grade Four, and the remedial practice has been expanded.

7) The topics which have been stepped-up from Grade Three ... are now included in Grade Four (see 1, 2, 3 of Third Grade).

Grade 5

1) Multiplication and division of common fractions have been stepped-up to Grade Six.

2) All work involving computation in finding area has been deferred until Grade Six.

3) The topics which have been stepped-up from Grade Four and are now included in Grade Five are as follows:

   a. Long division of whole numbers

   b. Addition and subtraction of common fractions with expanded practice.

Grade 6

1) All work in percentage has been stepped-up to Grade Seven.

2) All work with decimal fractions has been moved from the first half to the second half of Grade Six.

3) The reteaching and remedial work in addition and subtraction of common fractions has been expanded.

4) The topics which have been stepped-up from Grades Four and Five and are now included in Grade Six are as follows:

    a. All work involving computation in finding area.

    b. Multiplication and division of common fractions.[13]

In the work of the Committee of Seven and the Winnetka schools there had been an unusual wedding of theory and practice. The recommendations of the Committee were promptly incorporated into the program of the Winnetka schools and into the textbook series the Winnetka schools developed and followed. These books influenced other textbook series. Carleton Washburne published widely in the professional journals, co-authored the textbook series, and maintained an on-going research program within and without the realm of the work of the Committee of Seven.

Although Washburne kept abreast of educational theory and in later years altered his focus to encompass portions of meaning theory,[14], [15] it was his drill theory and the Committee's grade placement studies which influenced the movement that became a part of the structure of "Stepped-Up" textbooks across the country.

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[13] Ibid., Preface, Books 3, 4, 5, and 6.

The impetus for change, the problem of large numbers of school failures, was largely resolved and no major structural revision was to occur for another 35 years.

Groundwork for Change in the 1950's

Educational theory and educational practice are subjected to different pressures and respond to different stimuli. Each has its own ground-swell movements, periods of germination and quiescence and its own crystallizations.[16] Although the big ground-swell movement for educational practice was over and the Stepped-Up curriculum had become a part of the new crystallization, the work of the theorists had just begun. The ink on the new Stepped-Up textbooks had scarcely dried when a movement was launched in the theoretical realm which rendered certain aspects of the books theoretically obsolete.

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[14] Harry O. Gillet et al., Washburne Individual Arithmetic, Book Eight: The Meaning of Fractions (New York: The World Book Co., 1930).

[15] Tewksbury, op. cit., p. 415.

[16] A term employed by Alice Miel to indicate a state in which there is rigid resistance to change.

This new movement came in under the title of the "meaning" theory, a term which was employed by Brownell in 1935,[17] just five years after the 29th Yearbook of NSSE had come out in strong support of the use of drill and association psychology in arithmetic instruction. Meaning theory carried with it selected portions of Gestalt psychology.

The various schools of psychology had been absorbed into instructional programs in arithmetic in the sequence in which they had become popularized. In the 1930's association psychology was older, more firmly established and had a wider audience than did the "new" Gestalt psychology. Gestalt psychology was not as easily interpreted nor as readily followed as association psychology had been.

In an article entitled "The New Psychology of Learning" Wheeler challenged the atomistic drill type theory of learning in mathematics, favoring instead a Gestalt structure and orientation. "Learning," he said, "is not a matter of forming bonds, a process of putting pieces of experience together,"[18] rather it is "an orderly and organized process of differentiating general grasps of situations with respect to experience. The details emerge organized, as they differentiate from previous knowledge, in the face of new situations (not repeated ones)."[19]

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[17] Brownell, "Psychological Consideration," op. cit., p. 19.

[18] Raymond Wheeler, "The New Psychology of Learning," Tenth Yearbook of the National Council of Teachers of Mathematics (Washington, D. C.: NCTM, 1935), p. 238.

He also said:

"Subjects are inadequately learned when learned in isolation... No transfer will occur unless the material is learned in connection with the field to which transfer is desired."[20]

Meaning theory had a place for drill and association psychology and a place for Gestalt psychology but no place for either of the two branches in extreme form. Meaning theory overshadowed Wheeler's case and although meaning theory drew from Gestalt, Wheeler's Gestalt structure never came into full flower.

Brownell's broadest definition of the meaning theory was as follows:

> "This theory makes meaning, the fact that children shall see sense in what they learn, the central issue in the arithmetic instruction."[21]

Although Brownell stated that meaning theory utilized certain features of the two branches of psychology, he maintained that meaning theory was not eclectic because it also contained features which "are peculiarly its own."[22]

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[19] Ibid., p. 239. [20] Ibid., p. 239.

[21] Brownell, "Psychological Considerations," op. cit., p. 19.

More specifically he described meaning theory as follows:

> "Within the 'meaning' theory, the virtues of drill are frankly recognized.... Thus, drill is recommended when ideas and processes, already understood, are to be practiced to increase proficiency, to be fixed for retention, or to be rehabituated after disuse. But within the 'meaning' theory there is absolutely no place for the view of arithmetic as a heterogeneous mass of unrelated elements to be trained through repetition. The 'meaning' theory conceives of arithmetic as a closely knit system of understandable ideas, principles, and processes..... The true test is an intelligent grasp upon number relations and the ability to deal with arithmetical situations with proper comprehension of their mathematical as well as their practical significance."[23]

Experimental studies by meaning theorists have supported the view that under conditions of meaningful instruction children can learn certain skills considerably earlier than the mental-age standards set by the Committee of Seven. In the teaching of long division Beall ('32)[24] was able to achieve a saving of more than two full years and Grossnickle ('37)[25] achieved a saving of two years, four months over mental age standards established by the

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[22] Ibid., p. 19. [23] Ibid., p. 19.

[24] Ross H. Beall, "An Individual Instruction Unit in Long Division," (unpublished Doctor's dissertation, University of Iowa, 1932), p. 69.

[25] Foster E. Grossnickle, "An Experiment with Two Methods of Estimation of the Quotient," Elementary School Journal, XXXVII (May, 1937), pp. 668-77.

Committee of Seven.

Later, Winnetka (1939-40) too found meaningful instruction to be more productive than the drill method in the teaching of multiplication facts over 20.[26]

No widespread comprehensive study or studies employing meaning theory but replicating those studies completed by the Committee of Seven on mental age standards and grade placement has appeared in the literature, however.[27]

Change affecting the elementary school mathematics curriculum of the 1950's was slow, subtle, and sometimes inconsistent. The structural base remained essentially the same as it had been in the "Stepped-Up" arrangement of the 1930's. Addition and subtraction of common fractions had continued to be introduced in grade 5, multiplication and division of fractions and decimal fractions continued to be introduced in grade 6, and percentage was largely reserved for seventh grade instruction.[28]

"Spreading" of instruction over a number of grades in the more difficult topics such as multiplication and division sometimes resulted in undue repetition and fragmentation. The gradation of exercises sometimes mitigated against the formation of broad principles and the atomistic theory[29] was not altogether eliminated from the program despite its rejection by meaning theorists.

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[26] Tewksbury, op. cit., p. 415.

[27] Carleton Washburne's own comment on the studies which entailed cooperation of 500 American cities was as follows: "As far as I am aware it was the most extensive, longest continued scientific investigation in the history of education." p. 33 Washburne, op. cit., "Winnetka--The History & Significance of an Educational Experiment."

[28] Direct first-hand experience.

The Gestalt structure which Wheeler had advocated remained an untapped resource.

Impetus for Change in the 1960's and Beyond

Three distinct movements of change (all pressured by the event of Sputnik) characterized the elementary school mathematics curriculum of the 1960's. The first movement came from an extension of meaning theory and from within regular curriculum building channels in the elementary school field of operations. A few of these changes are cited as follows:

> Several of the topics which had been "Stepped-Up" in the 1930's through the 1950's were stepped "back" in the 1960's. In three of four standardized pupil textbooks examined addition and subtraction of fractions were introduced in grade 4 (rather than in grade 5); in three of four textbooks multiplication and division of fractions were introduced in grade 5 (rather than in grade 6); in four of four books decimals were introduced in grade 5 and in three of four cases multiplication of decimals was covered in grade 5; and an altered method of division (using successive subtractions) was followed in three of four cases.[30]

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[29] L. J. Thurstone, Primary Mental Abilities (Chicago: University of Chicago Press, 1938).

[30] Offerings from Silver Burdette (1966), Scott-Foresman and Co. (1967), American Book Co. (1966), and Harcourt Brace (1972) were examined.

Grossnickle and Reckzeh state that the subject matter which required four years to cover in the 1950's is covered in three years in the 1970's.[31]

The long trend (dating at least as far back as 1898) to eliminate and/or to postpone topics in elementary school mathematics was finally reversed. In the 1960's several topics were introduced earlier and the discovery phase of meaning theory was highlighted.

The second movement came when new mathematics topics such as set language and concepts, frames, inequalities and equalities, varied number bases, and probability and statistics, etc. were included at the elementary level in a broad mathematical rather than an arithmetical orientation.[32]

The second movement had originated in the graduate schools in the 1930's when the ideas of Abel and Galois began to be applied to the graduate curriculum. More than a century earlier Abel and Galois had discovered that an examination of the over-all structure of a mathematical system could lead to solutions of problems not otherwise solvable by available computational procedures.[33]

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[31] Grossnickle and Reckzeh, op. cit., p. 6.

[32] Ibid., p. 6.

[33] E. G. Begle, "Curriculum Research in Mathematics," Research and Development Toward the Improvement of Education, eds. Herbert J. Klausmeier and George T. O'Hearn (Madison, Wis.: Dembar Educational Research Services, Inc., 1968), p. 45.

In the late 1930's and in the 1940's revision along the same lines was begun in the under-graduate curriculum. In the 1950's mathematicians joined with high school teachers in bringing corresponding change to the secondary school curriculum. It was at this time that the status of mathematics education had come to be regarded as a national emergency. The appearance of Sputnik gave unprecedented impetus to the extension of these ideas to the elementary school level.

The impact of the revolution was so powerful and erupted so suddenly at the elementary school level that its mission is still on the point of being recognized.

It would seem that what is sought at each level from the elementary grades through the graduate school is that each student build his own structure of mathematics since the structure is a powerful organizer of knowledge. This entails the provision that educators set the stage and the scene for possible leaps of thought as the learner builds structure first from a small number of concepts which he extends until he eventually incorporates strategies of problem solving.[34]

This process places problem solving in the stellar role and relegates to computation the role of that of an important but subordinate member of the supporting cast.

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[34] Ibid., p. 42.

It would also seem that the Abel and Galois experience has its counterparts in the psychology of learning. This experience tends to support McKeachie's thesis that Thorndike's laws of learning have fallen from preeminence in basic learning theory and that the Law of Effect and the Law of Exercise ought no longer to play the major role in instruction.[35] It also tends to parallel Tolman's experience when he found that by the selective use of strategic principles of learning (following a Gestalt persuasion), laboratory animals learned through problem solving things they had never been specifically "taught."[36]

Begle contends that the "revolution" which began with Abel and Galois "has been successfully concluded," that "no new revolution is clearly in sight," and that effects of any possible stirrings of a new revolution "could not appear in the pre-college program for generations."[37]

Grossnickle and Reckzeh, writing in 1973, are of the persuasion that the curriculum in modern mathematics is now "quite stabilized," and that there is a shift from concern for new content to new ways of presenting the material.[38] If elementary school textbooks are a true index, the grade placement of topics has also stabilized.

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[35] W. J. McKeachie, "The Decline and Fall of the Laws of Learning." Educational Researcher (A Publication of the American Educational Research Association) Vol. 3, No. 3, March, 1974, pp. 7-11.

[36] Ernest R. Hilgard and Gordon H. Bower, Theories of Learning, 3d ed., (New York: Appleton-Century-Crofts, 1966), Chapter 7, "Tolman's Sign Learning", particularly p. 196.

[37] Begle, op. cit., p. 45.

The third movement--individualized instruction and modern technology--alone remains in flux. It has taken many forms including the nongraded school, programmed learning, individually prescribed instruction, and other programs fashioned along Dalton plan lines. It has utilized educational television and teaching machines, and its most recent and perhaps most promising technological tool is the computer.

The perseverance with which educators pursue the individualized instruction ideal and the wisdom with which educators utilize the technological tools will determine whether the system remains open and responsive or whether a new crystallization will be formed.

RECENT STUDIES IN INDIVIDUALIZED INSTRUCTION

The individualized instruction ideal and the curricular problem are summed up by Wilhelms as follows: "Curriculums are planned for groups rather than for individuals" and when we build curriculums we run the risk of subordinating the individual to the type. What is needed is that we look beyond the obvious and "provide room for radical differences in mode of approach" through infinitely varied content and method. The goal is essential, but the particular means are optional.[39]

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[38] Grossnickle and Reckzeh, op. cit., Preface.

He says further that curricular planning at its best tries to "furnish room within which the unique person can function as himself as he works his way under guidance toward goals which are in a deep sense universal."[40]

This interpretation of the central meaning of individualization of instruction presents a never-ending challenge to workers in the research field.

Much sincere effort is being expended in this direction at the present time.

Studies in that individualized instruction which does not utilize computer technology are described as follows:

Pigge and others[41] conducted a study in which student achievement in mathematics was increased by restructuring the learning environment of seventh grade students.

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[39] Wilhelms, op. cit., pp. 62-68.

[40] Ibid., p. 74.

[41] Fred I. Pigge and others, "Final Evaluation Report, Exemplary Middle School Mathematics," Bowling Green State University, Ohio, Office of Educational Research and Services: Galeon School System, Ohio, Publication date August, 1972.

The question which this group sought to answer was not whether individualized instruction was effective but rather which of three individualized methods was most effective. The first method was one with a team teaching approach, the second was a self-contained one-teacher approach, and the third was a technological approach using one teacher, one teacher aide and programmed materials with 30 teaching machines (Didactors).

The results showed the mean of the self-contained, one-teacher classes to be significantly higher than the means of the Didactor and team teaching groups in Stanford Arithmetic tests in computation, concepts, and applications.

The disadvantages that Pigge and others found in team teaching were that (1) teachers were not able to know each student well enough, since they worked with 50 to 60 per period (2) there was much record keeping (3) the noise factor was a deterrent for some students, and (4) it was difficult to motivate slow students.

Student shirking was a problem in the teaching machines (Didactors) group. The staff found many middle school students to be utterly without purpose, even though they had been told what to do. These students were too immature to recognize the shirking as a fault. This problem was met by daily individual conferences, by utilizing individual carrels, and by the use of motivational awards.

In the self-contained classroom organization one class was individualized in groups of 6-10 for a nine-week period, and a second class was completely individualized for the last 20 weeks of the school year. Problems encountered in the second class were that more work was involved for the teacher than was true for a regular class, and there was not a suitable test available to measure the student's growth in the real individualized situation. The teacher reported that students covered more material (than did the classes that were kept together), they made better grades, and hardly ever had homework.[42]

One variation on a modern tutorial system, Individually Prescribed Instruction (IPI), may also be cited.

Johnson and Ostrum[43] found in the second year of the IPI program middle elementary grade children in a low income elementary school gained skills in mathematics as rapidly as average pupils across the country and much more rapidly than pupils in three comparable low income schools.

Pupils in grades 4, 5, and 6 gained 9, 10, and 7 grade equivalent months during an eight-month period from

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[42] Ibid.

[43] Lary Johnson and Donald Ostrum "Second Year Evaluation, Individually Prescribed Instruction (IPI) Mathematics Project," Hall School, Minneapolis Public Schools, Pub. date Oct., 1971.

October to May.

Teachers preferred Individually Prescribed Instruction over traditional mathematics programs and pupils chose mathematics as one of their favorite subjects.

The teachers regarded the supplementary material and particularly the manipulative devices as very important. Thirty to forty per cent of class time was spent on materials and equipment.

Additional staff in this project (primary and intermediate) were the project coordinator, two floating teachers, and six teacher aides.

The teachers tutored individuals or small groups and spent little time lecturing to the entire class. Floating teachers presented seminar sessions on various topics.

The various settings in which the children worked were as follows: Pupil alone, teacher tutor, peer tutor, small group instruction, large group instruction (11 or more pupils), or seminar.

One recommendation which Johnson and Ostrum make is that horizontal movement from level to level for a particular topic area may be better than vertical movement from topic area to topic area.

A brief description of IPI as given by Johnson and Ostrum is shown below.

The IPI system was begun by the Learning Research and Development Center at the University of Pittsburgh in

1963. Since 1966 the program has been made available to interested schools throughout the country through a regional education laboratory (Research for Better Schools) which is supported by federal funds.

Overall goals of the IPI program as stated by Research for Better Schools[44] are as follows:

1) To enable each pupil to work at his own rate through the units of study which constitute the learning sequence.
2) To enable each pupil to attain a demonstrable degree of mastery.
3) To encourage self-initiation and self-direction.
4) To foster the development of problem solving thought processes.
5) To encourage self-evaluation and foster self-motivation in the learning process.

In a study testing the effectiveness of a Westinghouse Learning Center Program in reading and mathematics with educationally deprived children in grades 2, 3, and 4, Robert Tack[45] found that the Learning Center children performed equally well with children in the control group who received their instruction in self-contained classrooms.

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[44] Research for Better Schools as found in Johnson and Ostrum op. cit.

[45] Robert S. Tack, "The Effectiveness of the Westinghouse Learning Center Program Involving a Performance Contract on Reading and Mathematics Achievement of Educationally Deprived Children," (unpublished Doctor's dissertation, Brigham Young University, 1971).

The children in the experimental group were instructed with programmed materials and were motivated with various methods of positive reinforcement. The control group received instruction from State of California reading and mathematics textbooks but were not exposed to the special methods of positive reinforcement.

A GENERAL DESCRIPTION OF PLAN

The PLAN system has been set up for use in grades 1-12. It grew out of the findings of Project TALENT.[46] Conclusions from that study at the end of the five-year follow-up were that secondary and elementary educational programs had not adequately prepared students for decision-making or for the setting of realistic long-term educational goals with respect to career planning.

The general overall goals of Project PLAN correspond with those provided by the national report "Goals for Americans."[47] The central goals of this report point to "self fulfillment with respect to both occupational and avocational activities and roles and meeting citizenship responsibilities."[48]

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[46] Project TALENT is a follow-up study of 440,000 students in grades nine through twelve testing whether secondary education programs adequately prepared students for full utilization of their talents in career selection and preparation. See John C. Flanagan, "Functional Education for the Seventies," Phi Delta Kappan, September, 1967.

[47] "Goals for Americans," Report of the President's Commission on National Goals. The American Assembly, Columbia University, 1960.

The PLAN system contains five components, as follows: (1) A comprehensive set of behavioral objectives which are grouped or organized into modules in such a way as to provide units of instruction each of which the typical student completes in approximately two weeks; (2) a "teaching-learning unit" (TLU) which is a guide to the student in achieving the objectives in the module; (3) a set of criterion-referenced tests for the module; (4) procedures related to guidance and individual planning in which special training is given in decision-making important to the management of the program; and (5) evaluation and systems component in which the computer scores the tests, keeps files on the experiences and progress of each student, and keeps records of results obtained by various students so that the program may be continually responsive to needed revisions.[49]

Substantial research support is given to the five components. Emphasis should be made, however, on the fact that PLAN is not a curriculum development project and is not involved either in the development of objectives or of instructional materials. Its behavioral objects rather are "a sampling of all modern curriculum studies and all courses or programs of typical school systems."[50] PLAN draws from a large reservoir of commercially available instructional materials, organizing and selecting in anthological manner appropriate methods and materials which suit the attainment of the objectives.

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[48] John C. Flanagan, "Program for Learning in Accordance with Needs," Psychology in the Schools, April, 1969, pp. 133-136.

[49] Ibid.

PLAN's most unique research based feature is its provision for a means of assisting students in planning and decision-making activities. Students are encouraged to take responsibility for their personal, social, and educational development. The developing of independent learners is a central goal of the total program.

The orientation program is an essential part of this process. A student begins by planning a few steps of his Program of Studies and gradually expands his planning to cover increasingly larger blocks of time. As a student proves himself the check points become less essential, and in time the student is able to function quite independently of his teacher. He thus assumes joint responsibility with his teacher for his learning.[51]

Students at all levels learn how to locate a variety of instructional materials and how to operate audio-visual equipment geared to tutorial instruction.[52]

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[50] Shanner, op. cit., p. 3.

[51] Thomas J. Quirk, "The Student in Project PLAN: A Functioning Program of Individualized Education," Elementary School Journal, October, 1970, p. 45.

[52] Ibid., p. 43.

The student with his teacher makes decisions relative to the objectives, the instructional materials, the instructional procedures, and the length of time he will spend in studying the objectives.[53]

The testing program of PLAN serves an organizational and guidance function. PLAN employs four major types of tests. The first, the Achievement-Survey Tests, are designed for placement purposes. Module tests which follow indicate whether a student has attained the objectives of a particular module. PLAN Achievement Tests assess a student's progress after he has completed a group of modules.[54]

The fourth type, the Developed Ability Performance Tests assess specific skills, aptitude, and ability rather than containing strictly "achievement" components.[55] This set of tests measures many of the same types of aptitude and ability components that are measured in Project TALENT Aptitude and Ability Tests.[56]

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[53] Ibid., p. 43.

[54] Ibid., p. 51.

[55] Ibid., p. 53.

[56] John C. Flanagan et al., "The American High School Student." Final Report for Cooperative Research Project No. 635, U. S. Office of Education, Dept. of Health, Education, & Welfare, 1964.

Chapter 3

DESIGN OF THE INVESTIGATION

The study purported to investigate possible performance differences between PLAN and Non-PLAN middle elementary grade mathematics students when exposed to the same standardized test. To this end achievement by PLAN and Non-PLAN students in grades 4, 5, and 6 were measured by the Otis-Lennon Intelligence Test and the Metropolitan '70 Standard Achievement Test, Intermediate Battery.

PLAN's central goal of developing independent learners who share with the computer and their teacher the responsibility for their instruction is a unique feature of this modern program. Through this goal of PLAN a new universal dimension may one day be attained, but at present there is no objective way to measure this attribute.

In time new standardized tests for the elementary level may be devised which will be geared toward the individual, measuring not only the breadth but the depth of the student's knowledge. At present, however, we are still bound by norm-referenced standardized tests which measure one dimension, and it is upon these tests that our present experimental studies must rely.

The Metropolitan '70 tests measure achievement in the modern mathematics curriculum which was developed in the 1960's. The modern mathematics curriculum includes a mixture of "new mathematics" or the mathematics of the physical sciences (MPS) and the arithmetic of the 1950's. The influence of the MPS as traced in the separate subtests of Metropolitan '70 may be noted as follows: In the Concepts subtest 50% of the items reflect MPS influence. In Computation and Problem Solving the MPS influence is limited to problems based on arithmetic in frames with 12-1/2% of the items in Computation utilizing this approach and 14% of the items in Problem Solving employing it.

Although both the PLAN schools and the traditional schools had high percentages of minorities and low socioeconomic whites, no achievement data was gathered with respect to minority composition. The following approximate minority-majority percentages for the 1972-1973 school year might be noted, however: PLAN school I: 33-1/3% Spanish-American, 33-1/3% black, and 33-1/3% low socioeconomic white. PLAN school II: 33-1/3% Spanish-American, 15% black, and 51-2/3% low to lower socioeconomic white. District-wide percentages (including PLAN schools): 20% Spanish-American, 16% black, and 64% low to middle socioeconomic white. Traditional schools: 17% Spanish-American, 14% black, and 69% low to middle socioeconomic white. The two traditional schools which had completely white populations were eliminated from the study.

The organization of the data was built around two major aspects of inquiry. In the first, all students in

PLAN school I and PLAN school II were compared by IQ and performance and by grade with all students in traditional programs by grade. Mean IQ scores were determined as were each of the mean scores by achievement subtest (Computation, Concepts, Problem Solving, and Total Mathematics).

Cochran's C and Bartlett tests were run for determining homogeneity of variances, and the Scheffe procedure was followed in determining where the differences lie.

Significant differences in performance subtest means were examined in terms of IQ predictions.

The second question which was considered was whether PLAN might be more effective with high, medium, or low IQ students. Scores within each grade level and each subtest were delineated by IQ level, i.e. low IQ (89 and below), medium IQ (90 to 110), and high IQ (111 and above).

Here too Cochran's C and Bartlett tests were utilized for determining homogeneity of variances, and the Scheffe procedure was followed in determining where the differences lie.

Performance was analyzed by subtests in terms of IQ.

The number of subjects in the breakdown by IQ level is given in the following table:

Table 1

NUMBER OF SUBJECTS BY SCHOOL

(Non-PLAN, PLAN I, PLAN II)

GRADE	IQ 89 and Below			IQ 90 - 110			IQ 111 and Above		
	N-P	PI	PII	N-P	PI	PII	N-P	PI	PII
4	112	35	21	170	29	20	88	5	5
5	83	36	20	169	33	22	75	8	2
6	62	35	21	146	37	34	58	12	12
TOTAL	257	106	62	485	99	76	221	25	19

Chapter 4

STATISTICAL RESULTS

The statistical results are presented in two main parts. Part I includes the data for the three groups (Non-PLAN, PLAN school I, and PLAN school II), showing IQ Total for each grade (4, 5, and 6) and performance scores for each mathematics subtest (Computation, Concepts, Problem Solving, and Total Mathematics) by grade.

Since the Non-PLAN group showed significantly higher scores in IQ in all three grades, IQ and performance scores in Part II were rearranged for further analysis according to high, medium, and low IQ subjects. Scores thus differentiated yielded data which showed further where the differences between the two groups lay.

PART I - NON-DIFFERENTIATED DATA

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable IQ Total at the fourth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 2.

Table 2

Means, Standard Deviations, and Ns of the Variable IQ Total at the Fourth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	98.48	15.90	370
PLAN I	89.59	13.87	69
PLAN II	92.00	15.96	46

The analysis of variance summary of this data is presented in Table 3.

Table 3

Analysis of Variance Summary of the Variable IQ Total at the Fourth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	5661.00	2	2830.50	11.58	.01
Error	117834.00	482	244.47		
Total	123495.00	484			

Since the F was significant at the .01 level, it was concluded that there was a significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

A Scheffe comparison was subsequently performed in an attempt to isolate the cause of this difference. The .05 level was utilized in this procedure.

The Scheffe procedures for the variable IQ Total at the fourth grade level indicated that the group Non-PLAN mean was significantly higher than the group PLAN I mean and group PLAN II mean, while the latter two groups did not differ significantly from each other.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Computation at the fourth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 4.

Table 4

Means, Standard Deviations, and Ns of the Variable Computation at the Fourth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	4.54	1.29	351
PLAN I	3.70	1.02	67
PLAN II	3.76	1.19	45

The analysis of variance summary of this data is presented in Table 5.

Table 5

Analysis of Variance Summary of the Variable Computation at the Fourth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	56.26	2	28.13	18.24	.01
Error	709.32	460	1.54		
Total	765.57	462			

Since the F was significant at the .01 level, it was concluded that there was a significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

A Scheffe comparison was subsequently performed in an attempt to isolate the cause of this difference. The .05 level was utilized in this procedure.

The Scheffe procedures for the variable Computation at the fourth grade level indicated that the group Non-PLAN mean was significantly higher than the group PLAN I mean and group PLAN II mean, while the latter two groups did not differ significantly from each other.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Concepts at the fourth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 6.

Table 6

Means, Standard Deviations, and Ns of the Variable Concepts at the Fourth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	4.42	1.49	349
PLAN I	3.56	1.30	67
PLAN II	3.88	1.42	44

The analysis of variance summary of this data is presented in Table 7.

Table 7

Analysis of Variance Summary of the Variable Concepts at the Fourth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	48.89	2	24.45	11.46	.01
Error	974.92	457	2.13		
Total	1023.82	459			

Since the F was significant at the .01 level, it was concluded that there was a significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

A Scheffe comparison was subsequently performed in an attempt to isolate the cause of this difference. The .05 level was utilized in this procedure.

The Scheffe procedures for the variable Concepts at the fourth grade level indicated that the group Non-PLAN mean was significantly higher than the group PLAN I mean and group PLAN II mean, while the latter two groups did not differ significantly from each other.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Problem Solving at the fourth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 8.

Table 8

Means, Standard Deviations, and Ns of the Variable Problem Solving at the Fourth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	4.19	1.60	350
PLAN I	3.37	1.31	67
PLAN II	3.93	1.56	45

The analysis of variance summary of this data is presented in Table 9.

Table 9

Analysis of Variance Summary of the Variable Problem Solving at the Fourth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	38.51	2	19.25	7.89	.01
Error	1119.71	459	2.44		
Total	1158.22	461			

Since the F was significant at the .01 level, it was concluded that there was a significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

A Scheffe comparison was subsequently performed in an attempt to isolate the cause of this difference. The .05 level was utilized in this procedure.

The Scheffe procedures for the variable Problem Solving at the fourth grade level indicated that the group Non-PLAN mean and the group PLAN II mean were both significantly higher than the group PLAN I mean but did not differ significantly from each other.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Total Math at the fourth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 10.

Table 10

Means, Standard Deviations, and Ns of the Variable Total Math at the Fourth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	4.34	1.38	349
PLAN I	3.49	1.10	67
PLAN II	3.79	1.23	44

The analysis of variance summary of this data is presented in Table 11.

Table 11

Analysis of Variance Summary of the Variable Total Math at the Fourth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	47.54	2	23.77	13.53	.01
Error	803.25	457	1.76		
Total	850.79	459			

Since the F was significant at the .01 level, it was concluded that there was a significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

A Scheffe comparison was subsequently performed in an attempt to isolate the cause of this difference. The .05 level was utilized in this procedure.

The Scheffe procedures for the variable Total Math at the fourth grade level indicated that the group Non-PLAN mean was significantly higher than the group PLAN I mean and group PLAN II mean, while the latter two groups did not differ significantly from each other.

Grade Five Series

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable IQ Total at the fifth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 12.

Table 12

Means, Standard Deviations, and Ns of the Variable IQ Total at the Fifth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	98.72	14.75	327
PLAN I	92.17	13.61	77
PLAN II	90.89	12.17	44

The analysis of variance summary of this data is presented in Table 13.

Table 13

Analysis of Variance Summary of the Variable IQ Total at the Fifth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	4389.00	2	2194.50	10.69	.01
Error	91349.00	445	205.28		
Total	95738.00	447			

Since the F was significant at the .01 level, it was concluded that there was a significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

A Scheffe comparison was subsequently performed in an attempt to isolate the cause of this difference. The .05 level was utilized in this procedure.

The Scheffe procedures for the variable IQ Total at the fifth grade level indicated that the group Non-PLAN mean was significantly higher than the group PLAN I mean and group PLAN II mean, while the latter two groups did not differ significantly from each other.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Computation at the fifth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 14.

Table 14

Means, Standard Deviations, and Ns of the Variable Computation at the Fifth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	5.24	1.12	324
PLAN I	4.46	1.21	73
PLAN II	4.44	1.02	38

The analysis of variance summary of this data is presented in Table 15.

Table 15

Analysis of Variance Summary of the Variable Computation at the Fifth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	50.92	2	25.46	20.17	.01
Error	545.17	432	1.26		
Total	596.09	434			

Since the F was significant at the .01 level, it was concluded that there was a significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

A Scheffe comparison was subsequently performed in an attempt to isolate the cause of this difference. The .05 level was utilized in this procedure.

The Scheffe procedures for the variable Computation at the fifth grade level indicated that the group Non-PLAN mean was significantly higher than the group PLAN I mean and group PLAN II mean, while the latter two groups did not differ significantly from each other.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Concepts at the fifth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 16.

Table 16

Means, Standard Deviations, and Ns of the Variable Concepts at the Fifth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	5.02	1.63	324
PLAN I	4.18	1.45	73
PLAN II	4.48	1.35	36

The analysis of variance summary of this data is presented in Table 17.

Table 17

Analysis of Variance Summary of the Variable Concepts at the Fifth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	47.56	2	23.78	9.55	.01
Error	1070.71	430	2.49		
Total	1118.27	432			

Since the F was significant at the .01 level, it was concluded that there was a significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

A Scheffe comparison was subsequently performed in an attempt to isolate the cause of this difference. The .05 level was utilized in this procedure.

The Scheffe procedures for the variable Concepts at the fifth grade level indicated that the group Non-PLAN mean was significantly higher than the group PLAN II mean which in turn was significantly higher than the group PLAN I mean.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Problem Solving at the fifth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 18.

Table 18

Means, Standard Deviations, and Ns of the Variable Problem Solving at the Fifth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	4.84	1.47	324
PLAN I	4.46	1.47	73
PLAN II	4.47	1.36	36

The analysis of variance summary of this data is presented in Table 19.

Table 19

Analysis of Variance Summary of the Variable Problem Solving at the Fifth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	11.91	2	5.95	2.79	N.S.
Error	917.64	430	2.13		
Total	929.54	432			

Since the F was not significant, it was concluded that there was no significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Total Math at the fifth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 20.

Table 20

Means, Standard Deviations, and Ns of the Variable Total Math at the Fifth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	4.98	1.17	322
PLAN I	4.31	1.25	73
PLAN II	4.38	1.14	33

The analysis of variance summary of this data is presented in Table 21.

Table 21

Analysis of Variance Summary of the Variable Total Math at the Fifth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	33.87	2	16.94	12.09	.01
Error	595.20	425	1.40		
Total	629.07	427			

Since the F was significant at the .01 level, it was concluded that there was a significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

A Scheffe comparison was subsequently performed in an attempt to isolate the cause of this difference. The .05 level was utilized in this procedure.

The Scheffe procedures for the variable Total Math at the fifth grade level indicated that the group Non-PLAN mean was significantly higher than the group PLAN I mean and group PLAN II mean, while the latter two groups did not differ significantly from each other.

Grade Six Series

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable IQ Total at the sixth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 22.

Table 22

Means, Standard Deviations, and Ns of the Variable IQ Total at the Sixth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	99.51	12.82	266
PLAN I	92.61	15.17	84
PLAN II	96.61	12.85	67

The analysis of variance summary of this data is presented in Table 23.

Table 23

Analysis of Variance Summary of the Variable IQ Total at the Sixth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	3126.00	2	1563.00	8.80	.01
Error	73540.00	414	177.63		
Total	76666.00	416			

Since the F was significant at the .01 level, it was concluded that there was a significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

A Scheffe comparison was subsequently performed in an attempt to isolate the cause of this difference. The .05 level was utilized in this procedure.

The Scheffe procedures for the variable IQ Total at the sixth grade level indicated that the group Non-PLAN mean was significantly higher than the group PLAN II mean which in turn was significantly higher than the group PLAN I mean.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Computation at the sixth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 24.

Table 24

Means, Standard Deviations, and Ns of the Variable Computation at the Sixth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	6.33	1.77	256
PLAN I	4.95	1.25	82
PLAN II	5.40	1.18	65

The analysis of variance summary of this data is presented in Table 25.

Table 25

Analysis of Variance Summary of the Variable Computation at the Sixth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	138.15	2	69.07	27.25	.01
Error	1013.93	400	2.53		
Total	1152.08	402			

Since the F was significant at the .01 level, it was concluded that there was a significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

A Scheffe comparison was subsequently performed in an attempt to isolate the cause of this difference. The .05 level was utilized in this procedure.

The Scheffe procedures for the variable Computation at the sixth grade level indicated that the group Non-PLAN mean was significantly higher than the group PLAN II mean which in turn was significantly higher than the group PLAN I mean.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Concepts at the sixth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 26.

Table 26

Means, Standard Deviations, and Ns of the Variable Concepts at the Sixth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	6.06	2.20	256
PLAN I	4.73	1.76	82
PLAN II	5.31	1.63	67

The analysis of variance summary of this data is presented in Table 27.

Table 27

Analysis of Variance Summary of the Variable Concepts at the Sixth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	119.34	2	59.67	14.48	.01
Error	1656.69	402	4.12		
Total	1776.03	404			

Since the F was significant at the .01 level, it was concluded that there was a significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

A Scheffe comparison was subsequently performed in an attempt to isolate the cause of this difference. The .05 level was utilized in this procedure.

The Scheffe procedures for the variable Concepts at the sixth grade level indicated that the group Non-PLAN mean was significantly higher than the group PLAN II mean which in turn was significantly higher than the group PLAN I mean.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Problem Solving at the sixth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 28.

Table 28

Means, Standard Deviations, and Ns of the Variable Problem Solving at the Sixth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	5.71	2.01	254
PLAN I	4.68	1.58	83
PLAN II	5.36	1.52	66

The analysis of variance summary of this data is presented in Table 29.

Table 29

Analysis of Variance Summary of the Variable Problem Solving at the Sixth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	67.91	2	33.96	9.89	.01
Error	1374.06	400	3.44		
Total	1441.97	402			

Since the F was significant at the .01 level, it was concluded that there was a significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

A Scheffe comparison was subsequently performed in an attempt to isolate the cause of this difference. The .05 level was utilized in this procedure.

The Scheffe procedures for the variable Problem Solving at the sixth grade level indicated that the group Non-PLAN mean was significantly higher than the group PLAN II mean which in turn was significantly higher than the group PLAN I mean.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Total Math at the sixth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 30.

Table 30

Means, Standard Deviations, and Ns of the Variable Total Math at the Sixth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	5.92	1.73	253
PLAN I	4.74	1.37	82
PLAN II	5.31	1.27	64

The analysis of variance summary of this data is presented in Table 31.

Table 31

Analysis of Variance Summary of the Variable Total Math at the Sixth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	92.98	2	46.49	18.29	.01
Error	1006.48	396	2.54		
Total	1099.46	398			

Since the F was significant at the .01 level, it was concluded that there was a significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

A Scheffe comparison was subsequently performed in an attempt to isolate the cause of this difference. The .05 level was utilized in this procedure.

The Scheffe procedures for the variable Total Math at the sixth grade level indicated that the group Non-PLAN mean was significantly higher than the group PLAN II mean which in turn was significantly higher than the group PLAN I mean.

PART II - DATA DIFFERENTIATED ACCORDING TO LOW, MEDIUM, AND HIGH IQ SUBJECTS

IQ 89 and Below, Grade Four Series

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable IQ 89 and Below at the fourth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 32.

Table 32

Means, Standard Deviations, and Ns of the Variable IQ 89 and Below at the Fourth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	80.33	7.58	112
PLAN I	79.26	8.15	35
PLAN II	78.62	7.95	21

The analysis of variance summary of this data is presented in Table 33.

Table 33

Analysis of Variance Summary of the Variable IQ 89 and Below at the Fourth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	70.00	2	35.00	0.58	N.S.
Error	9893.00	165	59.96		
Total	9963.00	167			

Since the F was not significant, it was concluded that there was no significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Computation at the fourth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 34.

Table 34

Means, Standard Deviations, and Ns of the Variable Computation at the Fourth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	3.56	0.93	102
PLAN I	3.26	0.87	35
PLAN II	3.14	0.72	20

The analysis of variance summary of this data is presented in Table 35.

Table 35

Analysis of Variance Summary of the Variable Computation at the Fourth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	4.50	2	2.25	2.80	N.S.
Error	123.59	154	0.80		
Total	128.09	156			

Since the F was not significant, it was concluded that there was no significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Concepts at the fourth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 36.

Table 36

Means, Standard Deviations, and Ns of the Variable Concepts at the Fourth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	3.11	0.72	101
PLAN I	2.88	0.85	35
PLAN II	2.77	0.73	19

The analysis of variance summary of this data is presented in Table 37.

Table 37

Analysis of Variance Summary of the Variable Concepts at the Fourth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	2.62	2	1.31	2.30	N.S.
Error	86.49	152	0.57		
Total	89.11	154			

Since the F was not significant, it was concluded that there was no significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Problem Solving at the fourth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 38.

Table 38

Means, Standard Deviations, and Ns of the Variable Problem Solving at the Fourth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	2.90	0.62	101
PLAN I	2.68	0.81	35
PLAN II	2.80	0.75	20

The analysis of variance summary of this data is presented in Table 39.

Table 39

Analysis of Variance Summary of the Variable Problem Solving at the Fourth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	1.26	2	0.63	1.35	N.S.
Error	71.24	153	0.47		
Total	72.50	155			

Since the F was not significant, it was concluded that there was no significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Total Math at the fourth grade level was tested utilizing a one-way analysis of variance.

The descriptive statistics of the groups are presented in Table 40.

Table 40

Means, Standard Deviations, and Ns of the Variable Total Math at the Fourth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	3.15	0.64	101
PLAN I	2.91	0.76	35
PLAN II	2.86	0.70	19

The analysis of variance summary of this data is presented in Table 41.

Table 41

Analysis of Variance Summary of the Variable Total Math at the Fourth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	2.41	2	1.21	2.65	N.S.
Error	69.22	152	0.46		
Total	71.63	154			

Since the F was not significant, it was concluded that there was no significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

IQ 89 and Below, Grade Five Series

The significance of difference between the grade

equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable IQ 89 and Below at the fifth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 42.

Table 42

Means, Standard Deviations, and Ns of the Variable IQ 89 and Below at the Fifth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	81.07	7.14	83
PLAN I	81.17	5.53	36
PLAN II	80.55	7.56	20

The analysis of variance summary of this data is presented in Table 43.

Table 43

Analysis of Variance Summary of the Variable IQ 89 and Below at the Fifth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	5.38	2	2.69	0.06	N.S.
Error	6333.69	136	46.57		
Total	6339.07	138			

Since the F was not significant, it was concluded that there was no significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Computation at the fifth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 44.

Table 44

Means, Standard Deviations, and Ns of the Variable Computation at the Fifth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	4.41	0.87	77
PLAN I	3.88	1.05	33
PLAN II	3.91	1.00	15

The analysis of variance summary of this data is presented in Table 45.

Table 45

Analysis of Variance Summary of the Variable Computation at the Fifth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	8.12	2	4.06	4.65	.05
Error	106.46	122	0.87		
Total	114.58	124			

Since the F was significant at the .05 level, it was concluded that there was a significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

A Scheffe comparison was subsequently performed in an attempt to isolate the cause of this difference. The .05 level was utilized in this procedure.

The Scheffe procedures for the variable Computation at the fifth grade level indicated that the group Non-PLAN mean was significantly higher than the group PLAN I mean and group PLAN II mean, while the latter two groups did not differ significantly from each other.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Concepts at the fifth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 46.

Table 46

Means, Standard Deviations, and Ns of the Variable Concepts at the Fifth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	3.73	0.69	77
PLAN I	3.62	0.96	33
PLAN II	3.38	0.76	14

The analysis of variance summary of this data is presented in Table 47.

Table 47

Analysis of Variance Summary of the Variable Concepts at the Fifth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	1.54	2	0.77	1.28	N.S.
Error	73.18	121	0.60		
Total	74.72	123			

Since the F was not significant, it was concluded that there was no significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Problem Solving at the fifth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 48.

Table 48

Means, Standard Deviations, and Ns of the Variable Problem Solving at the Fifth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	3.74	0.71	76
PLAN I	3.57	0.93	33
PLAN II	3.66	0.82	14

The analysis of variance summary of this data is presented in Table 49.

Table 49

Analysis of Variance Summary of the Variable Problem Solving at the Fifth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	0.63	2	0.32	0.51	N.S.
Error	74.48	120	0.62		
Total	75.11	122			

Since the F was not significant, it was concluded that there was no significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Total Math at the fifth grade level was tested utilizing a one-way analysis of variance.

The descriptive statistics of the groups are presented in Table 50.

Table 50

Means, Standard Deviations, and Ns of the Variable Total Math at the Fifth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	3.98	0.67	75
PLAN I	3.65	0.89	33
PLAN II	3.58	0.87	13

The analysis of variance summary of this data is presented in Table 51.

Table 51

Analysis of Variance Summary of the Variable Total Math at the Fifth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	3.55	2	1.77	3.08	.05
Error	67.90	118	0.58		
Total	71.45	120			

Since the F was significant at the .05 level, it was concluded that there was a significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

A Scheffe comparison was subsequently performed in an attempt to isolate the cause of this difference. The

.05 level was utilized in this procedure.

The Scheffe procedures for the variable Total Math at the fifth grade level indicated that the group Non-PLAN mean was significantly higher than the group PLAN I mean and group PLAN II mean, while the latter two groups did not differ significantly from each other.

IQ 89 and Below, Grade Six Series

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable IQ 89 and Below at the sixth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 52.

Table 52

Means, Standard Deviations, and Ns of the Variable IQ 89 and Below at the Sixth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	83.60	4.96	62
PLAN I	79.14	7.95	35
PLAN II	83.38	5.05	21

The analysis of variance summary of this data is presented in Table 53.

Table 53

Analysis of Variance Summary of the Variable IQ 89 and Below at the Sixth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	477.25	2	238.63	6.60	.01
Error	4158.25	115	36.16		
Total	4635.50	117			

Since the F was significant at the .01 level, it was concluded that there was a significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

A Scheffe comparison was subsequently performed in an attempt to isolate the cause of this difference. The .05 level was utilized in this procedure.

The Scheffe procedures for the variable IQ 89 and Below at the sixth grade level indicated that the group Non-PLAN mean and the group PLAN II mean were both significantly higher than the group PLAN I mean but did not differ significantly from each other.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Computation at the sixth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 54.

Table 54

Means, Standard Deviations, and Ns of the Variable Computation at the Sixth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	5.22	1.11	56
PLAN I	4.11	0.77	30
PLAN II	4.53	0.56	18

The analysis of variance summary of this data is presented in Table 55.

Table 55

Analysis of Variance Summary of the Variable Computation at the Sixth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	25.52	2	12.76	14.32	.01
Error	90.02	101	0.89		
Total	115.54	103			

Since the F was significant at the .01 level, it was concluded that there was a significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

A Scheffe comparison was subsequently performed in an attempt to isolate the cause of this difference. The .05 level was utilized in this procedure.

The Scheffe procedures for the variable Computation at the sixth grade level indicated that the group Non-PLAN mean was significantly higher than the group PLAN II mean which in turn was significantly higher than the group PLAN I mean.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Concepts at the sixth grade level was tested utilizing a one-wav analysis of variance. The descriptive statistics of the groups are presented in Table 56.

Table 56

Means, Standard Deviations, and Ns of the Variable Concepts at the Sixth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	4.54	1.33	56
PLAN I	3.68	0.94	30
PLAN II	4.22	0.75	19

The analysis of variance summary of this data is presented in Table 57.

Table 57

Analysis of Variance Summary of the Variable Concepts at the Sixth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	14.37	2	7.19	5.49	.01
Error	133.50	102	1.31		
Total	147.87	104			

Since the F was significant at the .01 level, it was concluded that there was a significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

A Scheffe comparison was subsequently performed in an attempt to isolate the cause of this difference. The .05 level was utilized in this procedure.

The Scheffe procedures for the variable Concepts at the sixth grade level indicated that the group Non-PLAN mean was significantly higher than the group PLAN II mean which in turn was significantly higher than the group PLAN I mean.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Problem Solving at the sixth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 58.

Table 58

Means, Standard Deviations, and Ns of the Variable Problem Solving at the Sixth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	4.23	0.82	56
PLAN I	3.71	1.01	30
PLAN II	4.19	0.71	19

The analysis of variance summary of this data is presented in Table 59.

Table 59

Analysis of Variance Summary of the Variable Problem Solving at the Sixth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	5.63	2	2.82	3.80	.05
Error	75.54	102	0.74		
Total	81.17	104			

Since the F was significant at the .05 level, it was concluded that there was a significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

A Scheffe comparison was subsequently performed in an attempt to isolate the cause of this difference. The .05 level was utilized in this procedure.

The Scheffe procedures for the variable Problem

Solving at the sixth grade level indicated that the group Non-PLAN mean and the group PLAN II mean were both significantly higher than the group PLAN I mean but did not differ significantly from each other.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Total Math at the sixth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 60.

Table 60

Means, Standard Deviations, and Ns of the Variable Total Math at the Sixth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	4.66	0.81	56
PLAN I	3.82	0.81	30
PLAN II	4.29	0.56	18

The analysis of variance summary of this data is presented in Table 61.

Table 61

Analysis of Variance Summary of the Variable Total Math at the Sixth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	13.87	2	6.94	11.64	.01
Error	60.21	101	0.60		
Total	74.08	103			

Since the F was significant at the .01 level, it was concluded that there was a significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

A Scheffe comparison was subsequently performed in an attempt to isolate the cause of this difference. The .05 level was utilized in this procedure.

The Scheffe procedures for the variable Total Math at the sixth grade level indicated that the group Non-PLAN mean was significantly higher than the group PLAN II mean which in turn was significantly higher than the group PLAN I mean.

IQ 90 to 110, Grade Four Series

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable IQ 90 to 110 at the fourth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in

Table 62.

Table 62

Means, Standard Deviations, and Ns of the Variable IQ 90 to 110 at the Fourth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	99.58	5.80	170
PLAN I	96.93	5.54	29
PLAN II	98.60	5.67	20

The analysis of variance summary of this data is presented in Table 63.

Table 63

Analysis of Variance Summary of the Variable IQ 90 to 110 at the Fourth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	180.00	2	90.00	2.72	N.S.
Error	7151.00	216	33.11		
Total	7331.00	218			

Since the F was not significant, it was concluded that there was no significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Computation at the fourth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 64.

Table 64

Means, Standard Deviations, and Ns of the Variable Computation at the Fourth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	4.52	1.01	162
PLAN I	4.08	0.89	28
PLAN II	4.08	1.21	20

The analysis of variance summary of this data is presented in Table 65.

Table 65

Analysis of Variance Summary of the Variable Computation at the Fourth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	7.23	2	3.62	3.53	.05
Error	212.29	207	1.03		
Total	219.52	209			

Since the F was significant at the .05 level, it was concluded that there was a significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

A Scheffe comparison was subsequently performed in an attempt to isolate the cause of this difference. The .05 level was utilized in this procedure.

The Scheffe procedures for the variable Computation at the fourth grade level indicated that the group Non-PLAN mean was significantly higher than the group PLAN I mean and group PLAN II mean, while the latter two groups did not differ significantly from each other.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Concepts at the fourth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 66.

Table 66

Means, Standard Deviations, and Ns of the Variable Concepts at the Fourth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	4.37	1.04	162
PLAN I	4.09	1.16	28
PLAN II	4.37	1.06	20

The analysis of variance summary of this data is presented in Table 67.

Table 67

Analysis of Variance Summary of the Variable Concepts at the Fourth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	1.91	2	0.96	0.85	N.S.
Error	233.02	207	1.13		
Total	234.93	209			

Since the F was not significant, it was concluded that there was no significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Problem Solving at the fourth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 68.

Table 68

Means, Standard Deviations, and Ns of the Variable Problem Solving at the Fourth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	3.99	1.17	163
PLAN I	3.91	1.21	28
PLAN II	4.32	0.92	20

The analysis of variance summary of this data is presented in Table 69.

Table 69

Analysis of Variance Summary of the Variable Problem Solving at the Fourth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	2.18	2	1.09	0.82	N.S.
Error	276.70	208	1.33		
Total	278.88	210			

Since the F was not significant, it was concluded that there was no significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Total Math at the fourth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 70.

Table 70

Means, Standard Deviations, and Ns of the Variable Total Math at the Fourth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	4.24	0.92	162
PLAN I	3.97	0.93	28
PLAN II	4.19	0.90	20

The analysis of variance summary of this data is presented in Table 71.

Table 71

Analysis of Variance Summary of the Variable Total Math at the Fourth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	1.79	2	0.89	1.06	N.S.
Error	175.08	207	0.85		
Total	176.87	209			

Since the F was not significant, it was concluded that there was no significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

IQ 90 to 110, Grade Five Series

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable IQ 90 to 110 at the fifth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 72.

Table 72

Means, Standard Deviations, and Ns of the Variable IQ 90 to 110 at the Fifth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	98.31	5.88	169
PLAN I	97.58	5.69	33
PLAN II	97.91	5.44	22

The analysis of variance summary of this data is presented in Table 73.

Table 73

Analysis of Variance Summary of the Variable IQ 90 to 110 at the Fifth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	15.00	2	7.50	0.22	N.S.
Error	7468.00	221	33.79		
Total	7483.00	223			

Since the F was not significant, it was concluded that there was no significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

The significance of difference between the grade

equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Computation at the fifth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 74.

Table 74

Means, Standard Deviations, and Ns of the Variable Computation at the Fifth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	5.18	0.88	167
PLAN I	4.55	0.82	30
PLAN II	4.84	0.76	18

The analysis of variance summary of this data is presented in Table 75.

Table 75

Analysis of Variance Summary of the Variable Computation at the Fifth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	11.24	2	5.62	7.54	.01
Error	158.15	212	0.75		
Total	169.39	214			

Since the F was significant at the .01 level, it was concluded that there was a significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

A Scheffe comparison was subsequently performed in an attempt to isolate the cause of this difference. The .05 level was utilized in this procedure.

The Scheffe procedures for the variable Computation at the fifth grade level indicated that the group Non-PLAN mean was significantly higher than the group PLAN II mean which in turn was significantly higher than the group PLAN I mean.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Concepts at the fifth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 76.

Table 76

Means, Standard Deviations, and Ns of the Variable Concepts at the Fifth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	4.76	1.09	167
PLAN I	4.08	0.87	30
PLAN II	5.33	1.09	18

The analysis of variance summary of this data is presented in Table 77.

Table 77

Analysis of Variance Summary of the Variable Concepts at the Fifth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	19.21	2	9.60	8.49	.01
Error	239.92	212	1.13		
Total	259.13	214			

Since the F was significant at the .01 level, it was concluded that there was a significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

A Scheffe comparison was subsequently performed in an attempt to isolate the cause of this difference. The .05 level was utilized in this procedure.

The Scheffe procedures for the variable Concepts at the fifth grade level indicated that the group PLAN II mean was significantly higher than the group Non-PLAN mean which in turn was significantly higher than the group PLAN I mean.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Problem Solving at the fifth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 78.

Table 78

Means, Standard Deviations, and Ns of the Variable Problem Solving at the Fifth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	4.62	1.09	168
PLAN I	4.66	0.88	30
PLAN II	5.09	1.14	18

The analysis of variance summary of this data is presented in Table 79.

Table 79

Analysis of Variance Summary of the Variable Problem Solving at the Fifth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	3.55	2	1.77	1.56	N.S.
Error	242.73	213	1.14		
Total	246.28	215			

Since the F was not significant, it was concluded that there was no significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Total Math at the fifth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in

Table 80.

Table 80

Means, Standard Deviations, and Ns of the Variable Total Math at the Fifth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	4.84	0.78	167
PLAN I	4.41	0.72	30
PLAN II	4.99	0.82	16

The analysis of variance summary of this data is presented in Table 81.

Table 81

Analysis of Variance Summary of the Variable Total Math at the Fifth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	5.52	2	2.76	4.55	.05
Error	127.41	210	0.61		
Total	132.93	212			

Since the F was significant at the .05 level, it was concluded that there was a significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

A Scheffe comparison was subsequently performed in an attempt to isolate the cause of this difference. The .05 level was utilized in this procedure.

The Scheffe procedures for the variable Total Math at the fifth grade level indicated that the group PLAN II mean and the group Non-PLAN mean were both significantly higher than the group PLAN I mean but did not differ significantly from each other.

IQ 90 to 110, Grade Six Series

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable IQ 90 to 110 at the sixth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 82.

Table 82

Means, Standard Deviations, and Ns of the Variable IQ 90 to 110 at the Sixth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	98.92	5.63	146
PLAN I	96.73	4.95	37
PLAN II	97.38	5.99	34

The analysis of variance summary of this data is presented in Table 83.

Table 83

Analysis of Variance Summary of the Variable IQ 90 to 110 at the Sixth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	175.00	2	87.50	2.81	N.S.
Error	6668.00	214	31.16		
Total	6843.00	216			

Since the F was not significant, it was concluded that there was no significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Computation at the sixth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 84.

Table 84

Means, Standard Deviations, and Ns of the Variable Computation at the Sixth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	6.05	1.29	135
PLAN I	5.11	0.85	36
PLAN II	5.37	0.73	33

The analysis of variance summary of this data is presented in Table 85.

Table 85

Analysis of Variance Summary of the Variable Computation at the Sixth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	31.25	2	15.62	11.86	.01
Error	264.71	201	1.32		
Total	295.96	203			

Since the F was significant at the .01 level, it was concluded that there was a significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

A Scheffe comparison was subsequently performed in an attempt to isolate the cause of this difference. The .05 level was utilized in this procedure.

The Scheffe procedures for the variable Computation at the sixth grade level indicated that the group Non-PLAN mean was significantly higher than the group PLAN I mean and group PLAN II mean, while the latter two groups did not differ significantly from each other.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Concepts at the sixth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 86.

Table 86

Means, Standard Deviations, and Ns of the Variable Concepts at the Sixth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	5.58	1.49	135
PLAN I	4.83	1.39	36
PLAN II	5.27	1.07	33

The analysis of variance summary of this data is presented in Table 87.

Table 87

Analysis of Variance Summary of the Variable Concepts at the Sixth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	16.59	2	8.30	4.14	.05
Error	402.66	201	2.00		
Total	419.25	203			

Since the F was significant at the .05 level, it was concluded that there was a significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

A Scheffe comparison was subsequently performed in an attempt to isolate the cause of this difference. The

.05 level was utilized in this procedure.

The Scheffe procedures for the variable Concepts at the sixth grade level indicated that the group Non-PLAN mean was significantly higher than the group PLAN II mean which in turn was significantly higher than the group PLAN I mean.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Problem Solving at the sixth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 88.

Table 88

Means, Standard Deviations, and Ns of the Variable Problem Solving at the Sixth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	5.36	1.33	133
PLAN I	4.92	1.24	37
PLAN II	5.46	1.07	32

The analysis of variance summary of this data is presented in Table 89.

Table 89

Analysis of Variance Summary of the Variable Problem Solving at the Sixth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	6.50	2	3.25	2.00	N.S.
Error	323.63	199	1.63		
Total	330.13	201			

Since the F was not significant, it was concluded that there was no significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Total Math at the sixth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 90.

Table 90

Means, Standard Deviations, and Ns of the Variable Total Math at the Sixth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	5.58	1.07	132
PLAN I	4.92	0.91	36
PLAN II	5.30	0.73	32

The analysis of variance summary of this data is presented in Table 91.

Table 91

Analysis of Variance Summary of the Variable Total Math at the Sixth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	12.73	2	6.36	6.44	.01
Error	194.80	197	0.99		
Total	207.53	199			

Since the F was significant at the .01 level, it was concluded that there was a significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

A Scheffe comparison was subsequently performed in an attempt to isolate the cause of this difference. The .05 level was utilized in this procedure.

The Scheffe procedures for the variable Total Math at the sixth grade level indicated that the group Non-PLAN mean was significantly higher than the group PLAN II mean which in turn was significantly higher than the group PLAN I mean.

IQ 111 and Above, Grade Four Series

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for thevariable IQ 111 and Above at the fourth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 92.

Table 92

Means, Standard Deviations, and Ns of the Variable IQ 111 and Above at the Fourth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	119.44	7.92	88
PLAN I	119.40	7.47	5
PLAN II	121.80	11.39	5

The analysis of variance summary of this data is presented in Table 93.

Table 93

Analysis of Variance Summary of the Variable IQ 111 and Above at the Fourth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	26.00	2	13.00	0.20	N.S.
Error	6207.00	95	65.34		
Total	6233.00	97			

Since the F was not significant, it was concluded that there was no significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

The significance of difference between the grade

equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Computation at the fourth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 94.

Table 94

Means, Standard Deviations, and Ns of the Variable Computation at the Fourth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	5.73	1.13	86
PLAN I	4.88	1.30	4
PLAN II	5.04	1.28	5

The analysis of variance summary of this data is presented in Table 95.

Table 95

Analysis of Variance Summary of the Variable Computation at the Fourth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	4.77	2	2.38	1.83	N.S.
Error	119.88	92	1.30		
Total	124.65	94			

Since the F was not significant, it was concluded that there was no significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Concepts at the fourth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 96.

Table 96

Means, Standard Deviations, and Ns of the Variable Concepts at the Fourth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	6.10	1.26	85
PLAN I	5.73	1.61	4
PLAN II	6.14	0.70	5

The analysis of variance summary of this data is presented in Table 97.

Table 97

Analysis of Variance Summary of the Variable Concepts at the Fourth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	0.56	2	0.28	0.18	N.S.
Error	143.13	91	1.57		
Total	143.69	93			

Since the F was not significant, it was concluded that there was no significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

2

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Problem Solving at the fourth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 98.

Table 98

Means, Standard Deviations, and Ns of the Variable Problem Solving at the Fourth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	6.13	1.30	85
PLAN I	5.65	1.48	4
PLAN II	6.92	1.32	5

The analysis of variance summary of this data is presented in Table 99.

Table 99

Analysis of Variance Summary of the Variable Problem Solving at the Fourth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	3.99	2	1.99	1.16	N.S.
Error	156.48	91	1.72		
Total	160.47	93			

Since the F was not significant, it was concluded that there was no significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Total Math at the fourth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 100.

Table 100

Means, Standard Deviations, and Ns of the Variable Total Math at the Fourth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	5.96	1.17	85
PLAN I	5.30	1.28	4
PLAN II	5.74	0.74	5

The analysis of variance summary of this data is presented in Table 101.

Table 101

Analysis of Variance Summary of the Variable Total Math at the Fourth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	1.82	2	0.91	0.68	N.S.
Error	122.34	91	1.34		
Total	124.16	93			

Since the F was not significant, it was concluded that there was no significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

IQ 111 and Above, Grade Five Series

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable IQ 111 and Above at the fifth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 102.

Table 102

Means, Standard Deviations, and Ns of the Variable IQ 111 and Above at the Fifth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	119.16	7.08	75
PLAN I	119.38	10.20	8
PLAN II	117.00	8.49	2

The analysis of variance summary of this data is presented in Table 103.

Table 103

Analysis of Variance Summary of the Variable IQ 111 and Above at the Fifth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	9.00	2	4.50	0.08	N.S.
Error	4507.00	82	54.96		
Total	4516.00	84			

Since the F was not significant, it was concluded that there was no significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Computation at the fifth grade level was tested utilizing a one-way analysis of variance.

The descriptive statistics of the groups are presented in Table 104.

Table 104

Means, Standard Deviations, and Ns of the Variable Computation at the Fifth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	6.32	0.98	71
PLAN I	6.24	1.19	8
PLAN II	5.45	1.91	2

The analysis of variance summary of this data is presented in Table 105.

Table 105

Analysis of Variance Summary of the Variable Computation at the Fifth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	1.49	2	0.74	0.72	N.S.
Error	80.50	78	1.03		
Total	81.99	80			

Since the F was not significant, it was concluded that there was no significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

The significance of difference between the grade

equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Concepts at the fifth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 106.

Table 106

Means, Standard Deviations, and Ns of the Variable Concepts at the Fifth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	7.05	1.57	71
PLAN I	6.65	2.27	8
PLAN II	6.50		1

The analysis of variance summary of this data is presented in Table 107.

Table 107

Analysis of Variance Summary of the Variable Concepts at the Fifth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	1.42	2	0.71	0.26	N.S.
Error	207.94	77	2.70		
Total	209.36	79			

Since the F was not significant, it was concluded that there was no significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II .

groups.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Problem Solving at the fifth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 108.

Table 108

Means, Standard Deviations, and Ns of the Variable Problem Solving at the Fifth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	6.60	1.35	71
PLAN I	6.93	1.79	8
PLAN II	8.10		1

The analysis of variance summary of this data is presented in Table 109.

Table 109

Analysis of Variance Summary of the Variable Problem Solving at the Fifth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	2.90	2	1.45	0.75	N.S.
Error	149.08	77	1.94		
Total	151.98	79			

Since the F was not significant, it was concluded that there was no significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Total Math at the fifth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 110.

Table 110

Means, Standard Deviations, and Ns of the Variable Total Math at the Fifth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	6.42	0.99	71
PLAN I	6.43	1.60	8
PLAN II	6.80		1

The analysis of variance summary of this data is presented in Table 111.

Table 111

Analysis of Variance Summary of the Variable Total Math at the Fifth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	0.15	2	0.07	0.07	N.S.
Error	86.49	77	1.12		
Total	86.64	79			

Since the F was not significant, it was concluded that there was no significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

IQ 111 and Above, Grade Six Series

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable IQ 111 and Above at the sixth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 112.

Table 112

Means, Standard Deviations, and Ns of the Variable IQ 111 and Above at the Sixth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	117.98	5.78	58
PLAN I	119.17	7.57	12
PLAN II	117.58	4.56	12

The analysis of variance summary of this data is presented in Table 113.

Table 113

Analysis of Variance Summary of the Variable IQ 111 and Above at the Sixth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	18.00	2	9.00	0.26	N.S.
Error	2760.00	79	34.94		
Total	2778.00	81			

Since the F was not significant, it was concluded that there was no significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Computation at the sixth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 114.

Table 114

Means, Standard Deviations, and Ns of the Variable Computation at the Sixth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	8.32	1.74	56
PLAN I	6.59	1.59	12
PLAN II	6.99	1.33	12

The analysis of variance summary of this data is presented in Table 115.

Table 115

Analysis of Variance Summary of the Variable Computation at the Sixth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	40.09	2	20.04	7.21	.01
Error	213.97	77	2.78		
Total	254.06	79			

Since the F was significant at the .01 level, it was concluded that there was a significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

A Scheffe comparison was subsequently performed in an attempt to isolate the cause of this difference. The .05 level was utilized in this procedure.

The Scheffe procedures for the variable Computation at the sixth grade level indicated that the group Non-PLAN mean was significantly higher than the group PLAN II mean which in turn was significantly higher than the group PLAN I mean.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Concepts at the sixth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 116.

Table 116

Means, Standard Deviations, and Ns of the Variable Concepts at the Sixth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	8.85	1.80	56
PLAN I	7.28	2.02	12
PLAN II	7.48	2.04	12

The analysis of variance summary of this data is presented in Table 117.

Table 117

Analysis of Variance Summary of the Variable Concepts at the Sixth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	36.96	2	18.48	5.31	.01
Error	268.28	77	3.48		
Total	305.24	79			

Since the F was significant at the .01 level, it was concluded that there was a significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

A Scheffe comparison was subsequently performed in an attempt to isolate the cause of this difference. The .05 level was utilized in this procedure.

The Scheffe procedures for the variable Concepts at the sixth grade level indicated that the group Non-PLAN mean was significantly higher than the group PLAN II mean which in turn was significantly higher than the group PLAN I mean.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Problem Solving at the sixth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 118.

Table 118

Means, Standard Deviations, and Ns of the Variable Problem Solving at the Sixth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	8.18	1.92	56
PLAN I	6.65	1.84	12
PLAN II	7.39	1.30	12

The analysis of variance summary of this data is presented in Table 119.

Table 119

Analysis of Variance Summary of the Variable Problem Solving at the Sixth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	25.96	2	12.98	3.88	.05
Error	257.33	77	3.34		
Total	283.29	79			

Since the F was significant at the .05 level, it was concluded that there was a significant difference between the grade equivalent means of the Non-PLAN, PLAN I, and PLAN II groups.

A Scheffe comparison was subsequently performed in an attempt to isolate the cause of this difference. The .05 level was utilized in this procedure.

The Scheffe procedures for the variable Problem

Solving at the sixth grade level indicated that the group Non-PLAN mean was significantly higher than the group PLAN II mean which in turn was significantly higher than the group PLAN I mean.

The significance of difference between the grade equivalent means of the three groups (Non-PLAN, PLAN I, and PLAN II) for the variable Total Math at the sixth grade level was tested utilizing a one-way analysis of variance. The descriptive statistics of the groups are presented in Table 120.

Table 120

Means, Standard Deviations, and Ns of the Variable Total Math at the Sixth Grade Level for the Three Groups

Group	Mean	Standard Deviation	N
Non-PLAN	8.15	1.58	56
PLAN I	6.63	1.72	12
PLAN II	7.08	1.36	12

The analysis of variance summary of this data is presented in Table 121.

Table 121

Analysis of Variance Summary of the Variable Total Math at the Sixth Grade Level for the Three Groups

Source	Sum of Squares	DF	Mean Squares	F	SIG
Between Groups	29.38	2	14.69	5.94	.01
Error	190.47	77	2.47		
Total	219.85	79			

Since the F was significant at the .01 level, it was concluded that there was a significant difference between the grade equivalent means of the Non-Plan, PLAN I, and PLAN II groups.

A Scheffe comparison was subsequently performed in an attempt to isolate the cause of this difference. The .05 level was utilized in this procedure.

The Scheffe procedures for the variable Total Math at the sixth grade level indicated that the group Non-PLAN mean was significantly higher than the group PLAN II mean which in turn was significantly higher than the group PLAN I mean.

Chapter 5

SUMMARY AND DISCUSSION

SUMMARY OF THE STUDY

The problem with which the present study was concerned was that of determining insofar as possible the effectiveness of PLAN as followed in two schools by students in middle elementary grade mathematics in District A of City C. Students of these schools were compared by IQ and performance with students in traditionally organized schools in the same district.

The population from which the sample was drawn is located in the industrial section (District A) of City C. There are approximately 39,000 persons residing in District A, of which 16 per cent are blacks and 20 per cent are Spanish-Americans. The range of the socio-economic strata is from low-low to upper middle class.

Subjects were classed as educationally disadvantaged with several schools in the district qualifying for Title I funds.

Scores are reported for 1350 students in grades four through six from the public schools of District A. Of this number 963 students were enrolled in Non-PLAN schools, 230 were enrolled in PLAN school I, and 157 were enrolled in PLAN school II. For 1972-1973, the year in which the data was gathered, PLAN had been in operation for three years in school I and for two years in school II.

The organization of the data was built around two major aspects of inquiry. In the first instance (Part I) all middle elementary grade students in PLAN school I and PLAN school II were compared by IQ and performance with all students in Non-PLAN schools by grade. Mean IQ scores and mean scores by achievement subtests (Computation, Concepts, Problem Solving, and Total Mathematics) were computed and significance of differences determined.

In the second instance (Part II) an attempt was made to determine whether PLAN might be more effective with high, medium, or low IQ students. Scores within each grade level and each subtest were delineated by low, medium, and high IQ level. Here too mean IQ scores by level and mean scores by achievement subtest were computed and significance of differences were determined.

The findings for Part I based on the non-differentiated data for the three grades and the three groups (Non-PLAN, PLAN school I, and PLAN school II) are summarized as follows:

The data showed the Non-PLAN students to hold significantly higher IQ scores throughout the three grades. Although performance matched these IQ predictions in nine of 12 possible cases with significantly higher means for the traditional schools, there were three exceptions as follows:

(1) In Problem Solving at the fourth grade level there was no significant difference between PLAN school II and Non-PLAN. (Both PLAN school II and Non-PLAN were significantly higher than PLAN school I.)

(2) In Problem Solving at the fifth grade level there was no significant difference between the traditional and the PLAN groups.

(3) In Concepts at the fifth grade level Non-PLAN was significantly higher than PLAN school II as predicted. However, PLAN school II was also in turn significantly higher in performance than PLAN school I in this subtest, although there was no significant difference in IQ between the two PLAN schools at this level.

In the data for Part II (data organized by IQ level) an important change in the relationship between IQ and performance scores emerged. In Part I the traditional schools had displayed significantly higher IQ means than did the PLAN schools in each of the three grade levels. In Part II this was not the case. With the re-grouping of low, medium, and high IQ students in each grade, the wide differences between PLAN and traditional IQ means were almost erased. The only subset in which a significant difference in IQ occurred was in the low IQ subset at the sixth grade level.

Attention is also drawn to the higher concentration of low IQ students and lower concentration of high IQ students in the PLAN schools as compared with students in the traditional schools. (See Table 1 in Chapter 3.)

The findings for subjects with IQ scores of 89 and below are summarized as follows: There was no significant difference in mean IQ in grades 4 or 5. Students in traditional and PLAN schools performed equally well in all subtests of grade 4 and in Concepts and Problem Solving in grade 5 with no significant difference between means in these subtests. Means of the traditional schools were significantly higher than PLAN school means in Computation and Total Math in grade 5.

In grade 6 IQ score means of the Non-PLAN and PLAN II school groups did not differ significantly from each other, and means of both groups were significantly higher than those of PLAN school I at the .01 level of confidence. These IQ predictions were born out at the .05 level of confidence in Problem Solving. In the Computation, Concepts, and Total Math subtests, however, the traditional schools tested significantly higher than PLAN II, which in turn was significantly higher than PLAN I.

The findings for subjects with IQ scores of 90 to 110 are summarized as follows: There was no significant difference in the IQ variable means in grades 4, 5, or 6. Traditional and PLAN school students performed equally well in Concepts, Problem Solving, and in Total Math at the fourth grade level and also equally well in Problem Solving at the fifth and sixth grade levels.

PLAN school II was significantly higher than Non-PLAN and PLAN school I in Concepts in grade 5.

Non-PLAN school means were significantly higher than the PLAN schools in Computation in the fourth grade (.05 level of confidence) and in the sixth grade (.01 level of confidence). In three cases (Computation in grade 5, Concepts in grade 6, and Total Math in grade 6) traditional schools tested significantly higher than PLAN school II, which was in turn significantly higher than PLAN I.

In the Total Math subtest in grade 5 Non-PLAN and PLAN II schools did not differ significantly from each other but both were significantly higher than PLAN I at the .05 level of confidence.

The findings for subjects with IQ scores of 111 and above are summarized as follows: There was no significant difference in mean for IQ or for any subtest variable for the three groups in grades 4 and 5.

There was no significant difference between groups in IQ in grade 6. However, the traditional group tested significantly higher than PLAN school II, which in turn tested significantly higher than PLAN I in each of the performance subtests.[1]

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[1] The levels of confidence were as follows: Problem Solving, .05; Computation, Concepts, and Total Math, .01.

When summarized in terms of IQ level by grade, the findings are as follows: PLAN and the traditional schools most nearly approximated one another's performance in grade 4. In eleven of twelve performance cells there was no significant difference between PLAN and Non-PLAN in terms of IQ levels. The single instance of significance was attained by the traditional schools in Computation in the middle IQ level.

Traditional schools were decidedly more effective than PLAN in performance in grade 6. In ten of twelve performance cells Non-PLAN exceeded IQ expectations with significantly higher performance means than those earned by the PLAN groups. PLAN performed equally well with Non-PLAN in Problem Solving at the middle IQ level with no significant difference (as per IQ prediction) and at the low IQ level where performance also matched IQ predictions, (i.e. Non-PLAN and PLAN school II means were significantly higher than PLAN school I, but Non-PLAN and PLAN II did not differ significantly from one another).

IQ predictions of no significant difference were met in seven of twelve performance cells in grade 5. PLAN school II mean in Concepts was significantly higher than traditional schools or PLAN I school mean at the middle IQ level. Traditional schools were significantly higher in Computation and Total Math at the low IQ level. Significance was shared between Non-PLAN and PLAN school II in

Total Math in the middle IQ level. In Computation, middle IQ level, the traditional schools were significantly higher than PLAN school II, which was in turn higher than PLAN school I.

OVERALL CONCLUSIONS AND DISCUSSION

Patterns were not always uniform throughout, but the following major distinctions were apparent in the results:

I. In comparisons between the two PLAN schools, PLAN school II (the "younger" PLAN school) was more effective than PLAN school I in Problem Solving (grade 4) and Concepts (grade 5) even though there was no significant difference in mean IQ.

Here, as in the case of the Pigge study cited earlier, the classroom teacher appeared to be one key factor. Although PLAN school I teachers had the benefit of more formal work in mathematics, PLAN school II teachers had had more years of experience in teaching, a broader experience in the teaching of mathematics, and appeared to be in closer touch with each individual student.

A second factor was that the size of the groups or classes in PLAN school II was smaller.

A third factor was that teacher and administrator training was reported to be somewhat better and computer operation was more efficient at this point.

II. The data most useful in comparing PLAN and Non-PLAN performance was that which had been differentiated according to high, medium, and low IQ subjects. This was due largely to the fact that traditional school students earned significantly higher IQ scores than did PLAN students in all three grades. (In the non-differentiated data, performance scores matched IQ predictions in 10 of 12 possible cases with traditional schools testing significantly higher than PLAN in all subtests except Problem Solving in grades 4 and 5.)

III. When performance scores were differentiated according to low, medium, and high IQ students, patterns of differences between PLAN and Non-PLAN students became apparent as follows:

A. In Problem Solving subtests PLAN schools were consistently competitive with traditional schools (equally effective in eight out of nine possible cases).

B. Traditional schools were often more effective in Computation subtests (significantly higher in six out of nine possible cases).

As one contemplates on the patterns found in A and B and on the points of greater emphasis in each program, it could be concluded that each system accomplished what it set out to accomplish. In PLAN schools more time was devoted to Problem

Solving than to the kind of drill which builds skills in Computation. The question of values therefore arises. Of the two subtests, Problem Solving is regarded as the more complex of the two. Yet PLAN schools with higher percentages of low IQ students were competitive with traditional schools in these tests. The question should be not which is more important, Computation or Problem Solving, but rather what can we do to insure the emergence of the best environment for promoting Problem Solving and the best environment for enhancing the skill of Computation. "What we need everlastingly to investigate," Brownell says, "is how to teach arithmetic better." This includes knowing what promotes success in each attribute.

C. Effectiveness in Concepts was divided between PLAN and Non-PLAN groups with PLAN II testing higher in one case and Non-PLAN groups testing significantly higher in three cases. In the remaining five Concepts subtests, PLAN and Non-PLAN were equally effective.

D. In terms of grade level, PLAN schools were more often equally or more effective than traditional schools in grades 4 and 5 (15 out of 18 cases).

E. In grade 6, traditional schools were significantly more effective in seven out of nine cases with the exceptions occurring in Problem Solving in the low and medium IQ range cases.

Two possible factors may have influenced the findings in D and E. First, it may be noted that 61% of the units in the curriculum from which the prescriptions for a sixth grader in PLAN are drawn are based on modern mathematics topics as compared with 23% in grade 4 and 38% in grade 5. Little of this modern mathematics content is measured in Metropolitan '70. (The percentage of modern mathematics items appearing in Metropolitan '70 is 12.1%, exclusive of Arithmetic in Frames items.) The extent to which modern mathematics topics were actually selected, however, is not known. The concentration in modern mathematics in PLAN then appears to be "heavy" (particularly in grade 6) when compared with traditional programs and with test items in Metropolitan '70. It may also be noted that modern mathematics tends to be regarded as more difficult to teach because of its relatively new appearance (in the 1960's) in the standardized textbooks.

A second possible explanation, also speculative, for the differences in grade level findings might be based on the nature of the children themselves. It has long been recognized by child development authorities and by classroom teachers alike that a special impetus for independent thinking and reasoning occurs at ages 10 and 11, the ages of most fourth and fifth grade students. Perhaps PLAN has simply drawn more carefully upon the independent thinking and reasoning ability of 10 and 11 year olds than upon that of 12 year olds.

Two general factors are believed to have influenced overall findings in the present study. These may be elaborated as follows:

1. As has been indicated earlier, PLAN schools showed a higher percentage of low ability students and a lower percentage of high ability students in comparison with percentages in traditional schools (See Table 1). This higher concentration of low IQ subjects may well have had a detrimental effect on performance scores.
2. High percentages of minority group subjects in PLAN schools may have influenced the findings.
3. The high rate of student mobility (as is noted in District A) may have had a more detrimental effect on the PLAN students than on those in traditional classrooms, since the newcomer to PLAN must undergo an orientation and adjustment period before he can begin to move forward in PLAN.

RECOMMENDATIONS

As the time of dramatic change draws to a close and the curriculum as we know it to be across the nation approaches a point of stabilization, the role of individualized instruction becomes increasingly important as it provides a means for keeping curricular doors open.

It is recommended that a future study in District A of City C (or in any PLAN - Non-PLAN setting) might be made to explore the role of Problem Solving and Computation in greater detail in each of the programs.

It is further recommended that a future follow-up study in District A of City C be built only around those students who have been involved in the program for three years, four years, or for the full period of PLAN's operation. This would tend to offset the detrimental effect of the high rate of student mobility in the district.

A third recommendation is for the development of additional measurement tools designed to measure in depth as well as in breadth reasoning skills and non-verbal as well as verbal reasoning.

Some of PLAN's finest accomplishments have yet to be measured in objective ways. Teachers and administrators have found that PLAN students are better able to follow directions and to work independently. Parents have found that their children are better able to make independent decisions in the home after their exposure to PLAN. Parents, teachers, administrators, and other interested adults have all noted keener reasoning ability emerging in children in PLAN than they had heretofore believed to be possible in children of such tender years.

PLAN researchers are not the first scientists to have become convinced that they have discovered a new attribute or a new "element" as it were, but until this attribute can be isolated and appropriately measured the research phase has only just begun and the PLAN "system".

is incomplete.

Since there is much correlation with science in PLAN's instructional program in mathematics, a fourth recommendation is that a study be made of possible close correlation between science and mathematics scores earned by PLAN students in these two subtests of Metropolitan '70.

When these recommendations have been met, it is quite possible that many other fine things will emerge and/or will fall to place. These include (1) greater flexibility in the manner in which classes of children and individual students can move into and out of the program, (2) increased provisions for individual differences among PLAN teachers, and (3) a closer partnership between PLAN teachers and PLAN designers and researchers.

EPILOGUE

On concluding the inquiry the present investigator has come to think with Baker that the "promise" of PLAN as a computer-based instructional management (CBIM) system "far exceeds the present accomplishments."[1]

The eventual emergence of PLAN to a leadership position in the elementary school mathematics field will undoubtedly be predicated on the extent to which PLAN policy makers and researchers can meet the challenges Baker poses in his 1971 critique of CBIM systems[2] and his example of an improved CBIM-CA system (MICA) of 1972.[3]

This view is expressed not only on the basis of the data reported but also from the investigator's observations of PLAN as it was found to be followed in mathematics classes in both advantaged and disadvantaged settings in 1973-1974.

The first critique and example has to do with the burdens which CBIM systems appeared to impose on teachers at that time.

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[1] Frank B. Baker, "Computer-Based Instructional Management Systems: A First Look," Review of Educational Research, Vol. 41, No. 1, February, 1971, p. 68.

[2] Ibid., pp. 51-68.

[3] George Behr, et al., "Managed Instruction with Computer Assistance," University of Wisconsin, January, 1972 (Mimeographed).

Completely individualized instruction in which each student is working at a different rate on different materials towards differing goals imposes a considerable managerial work load on the teacher. Despite managerial assistance by the computer and the half-time services of a teacher aide, six out of seven teachers contacted and/or observed were overburdened by the program. One teacher remarked that he never sat down at his desk once during the first month of the program's operation.

Another teacher who was involved with a queue of students waiting for explanations, evaluations, and prescriptions was unavailable for dealing with a more pressing student problem which arose. In this case, attending to indivualized needs defeated its own larger purposes because the teacher had more system and more individualization than he could comfortably manage.

While computer-based instructional management systems promise to have a profound effect on the future of education, the present obligations these systems carry to the persons presently involved need also to be respected.

The first provision Baker's 1972 exemplary systems makes for freeing the teacher is that of quick and convenient access to information required for managing the instructional process. Summary print-outs are provided by the end of the last class period of the day so that the teacher has these for overnight planning, whereas in PLAN the teachers receive these surprises the following day in the morning when only quick cursory study of them is possible. A computer communications terminal in the classroom (for which the optical scanner and the telephone play a part) enables the teacher to obtain information from the computer and to provide the computer with data.

The other two major components in Baker's MICA system are a set of computer programs that implement a number of data processing capabilities needed by the teacher, and a data base consisting of descriptions of the curriculum in use, possible instructional procedures to achieve the objectives of the curriculum, and performance data on the teacher's students.

In this way the system acts only as an information source so that all actual educational decisions can be made by the teacher and/or student working together. The teacher is therefore free to ignore the information provided by the system and to proceed with an action of his own choosing. The teacher is provided with suggested alternative student prescriptions which he can accept, reject, or modify, and a way is provided for the emergence of the spontaneity of the teacher's own individual teaching techniques. This sort of flexibility by which the teacher can move in and out of the system and can keep in closer two-way communication with the computer is a decided advantage. Individual pupil needs cannot be met successfully at the sacrifice of individual teacher needs -- the two must go hand in hand.

A second critique that Baker makes is that "Published accounts of PLAN do not indicate the guide lines by which instructional units have been constructed nor do they indicate the spectrum of units presently available."

This was also found to be true. Advertising and sample materials were supplied by the sales representative, an instructional objectives catalog was available from the publisher, and a set of teaching-learning units was furnished by a PLAN teacher. The guidebook which draws the collection together, however, was not available for purchase or loan from anyone.

The teaching-learning units draw upon various available published textbook materials. Instructions in these conventional books usually presuppose interpretation and explanation by a teacher. When one PLAN teacher was commended for the work he had done in problem solving his comment was, "These children are solving problems all the time." A need does appear to exist for curricular materials which are functionally different, ones which can more readily be adapted by the teacher for the student in the individualized scheme.

A third critique is that in CBIM systems interpretation of computer-generated reports and data is left to the teacher. "Completely lacking," says Baker, "has been a description of how the teachers employ these reports to manage the classroom and any evidence that the CBIM systems result in a more effective role for the teacher." Baker labels the diagnostic and prescriptive procedures as "rudimentary," stating that "Much work of both a theoretical and applied nature is needed to put these procedures on a much firmer basis."

While it is true that in many respects it would seem that CBIM materials have been placed in the hands of teachers before some such materials have been thoroughly "road tested" in a research setting, one of the fine features of PLAN is that its designers are constantly striving for improvement in this "road testing" process in the evolution of what promises eventually to be an effective, complete system.

Even while these pages are being written, PLAN A, a "streamlined" version of the PLAN here discussed, has already been implemented into the PLAN schools of District A, City C.

Mathematics is a difficult subject to individualize insofar as instruction is concerned. A whole series of interdependencies is involved. As Skemp has pointed out, if a particular level of mathematics concepts and abstractions is imperfectly understood "everything from then on is in peril." Contributory concepts needed for each new stage of abstraction must be available. This dependency, he maintains, is probably greater in mathematics than in any other subject.[4]

In a study in reading in grades three through six with essentially the same PLAN, Non-PLAN subjects as the present study (District A, City C),[5] significant gains above expectancy were found with the grade five and grade six PLAN school subjects. Expectancy alone was attained by subjects at these levels in the Non-PLAN schools. The potential for similar gains by mathematics students in PLAN in District A, City C may one day yet be achieved.

The attainment of such potential is predicated not only on "next steps" which are relatively close to where the present study points (as detailed in the Recommendations section of the present study) but also upon changes envisioned in the broader spectrums in which PLAN operates. The critiques referred to in this Epilogue suggest some directions which these changes might take as follows:

1. The instructional materials spectrum. Some fundamental distinctions might be traced between the development of the mathematics curriculum and its attending instructional materials and the reading curriculum and its materials in the elementary school. Slightly more than one hundred years ago, arithmetic

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[4] Richard R. Skemp, The Psychology of Learning Mathematics (Middlesex, England: Penguin Books, Ltd., 1971), pp. 34, 35.

[5] Foundation for Individualized Evaluation and Research, Fall, 1973.

was regarded as the most important subject in the elementary school, and more time was allotted to it than to any other subject.[6] A trend to eliminate topics from the arithmetic curriculum and to reduce its time allotment was begun in Boston in 1845[7]--a trend which was not reversed in the elementary school until the 1960's. As arithmetic declined in its role of importance and its instructional materials became encapsulated into an increasingly narrow structural mold, reading materials were proliferated and reading rose to the preferential position it holds today in the elementary school program.

Even though volumes of materials were produced during the mathematics "revolution" of which Begle wrote, the calibre of instructional materials in the elementary school mathematics still lags at least 30 or 40 years behind the calibre of instructional materials that are available in reading.

Two major needs exist. One is for a "new" kind of instructional materials. (The second is for a modern mathematics supplement to accompany present norm referenced standardized tests.)

The "new" kind of instructional materials envisioned are ones like Wheeler had in mind when in "The New Psychology" he wrote of a truly Gestalt structural base for mathematics instruction.

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[6] H. L. Metter, "The Arithmetic Curriculum Since 1860" (unpublished Doctor's dissertation, University of Illinois, 1933).

[7] Ibid.

In the view of the present writer such a textbook or such materials should be written first for middle elementary grade pupils, for it is there that the die is cast for foundations in mathematics reasoning. As Piaget pointed out so graphically in "The Rules of the Game," the reasoning ability of 10 and 11 year olds is characterized by a special clarity that is never possible before or after that time.[8] Just as the primary grades must furnish the foundation for the child's reading "career," the middle elementary grades must furnish the foundation for the child's "career" in mathematical reasoning.

2. The measurement spectrum. The second major need, i.e. the need for a modern mathematics supplement to accompany the present norm referenced standardized test, is fully as important as the first.

Until and unless somewhere in the standardized testing process provision is made for the curriculums that are "different" no innovative curriculum can long survive.

Just as we need to build unceasingly a type of program which respects and encourages unique differences in individuals so too must we build unceasingly those environments which encourage unique differences in pioneering programs.

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[8] Jean Piaget, "The Rules of the Game" in The Moral Judgment of the Child. 1932.

The teacher who teaches a specific collection of mathematics topics has a right and an obligation to ask, "How does my instruction in these topics and in this curriculum compare over time with that of other teachers in related programs who have elected to teach the same topics and/or the same curriculum?" This teacher or these teachers may or may not be affiliated with an organized program such as PLAN.

It has long been a weakness of experimental mathematics curriculum programs that no long-range provision has been made at the outset for the emergence of a test standardized on the basis of the unique curriculum that is developed and on the population which followed or follows that curriculum rather than only upon an "average" curriculum from which national norms are determined.

PLAN does not reveal what it has in mind for the future. It has many measurement instruments in addition to the criterion-referenced tests which are now utilized primarily so as to locate the student approximately for his next instruction. It also supplies monthly and quarterly reports detailing the effectiveness of the teaching learning units. Westinghouse Learning Corporation maintains an educational services center (SCORE) which has a library of

8,000 instructional objectives and 20,000 related test items.

Hopefully PLAN's testing instruments and the data PLAN has amassed from present and past students in PLAN may be utilized in the evolution of possible national testing instruments which will be flexible enough to provide for "minority" as well as "majority" programs in its supplementary offerings.

While Metropolitan '70 gives an excellent description of the part of the "iceberg" which is visible above the surface, our curiosity is greatly aroused as to what lies below.

Even as these pages are being written, new guidelines are being drawn for new instruments of evaluation.

A more thorough discussion of the use of tests in measuring the effectiveness of educational programs, methods, and instructional materials for example can be found in Tyler and Wolf's book "Crucial Issues in Testing." In this treatment Tyler contends that the use of conventional standardized achievement tests for these purposes must be seriously questioned.[9]

PLAN can move no farther ahead than commercially available instructional materials can move. Moreover PLAN can attain and retain its status in the field only insofar as measuring devices can describe and assess its effectiveness.

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[9] Ralph W. Tyler and Richard M. Wolf, Crucial Issues in Testing (Berkeley, California: McCutchan Publishing Co., 1974).

Much has been said about criticisms of CBIM systems and little has been said about their promise in this treatment. It is nevertheless true that these systems have reached out to a new dimension in the research of the dynamics of instruction as it relates to individuals.

BIBLIOGRAPHY

A. BOOKS

Begle, E. G. "Curriculum Research in Mathematics," *Research and Development Toward the Improvement of Education*, eds. Herbert J. Klausmeier and George T. O'Hearn. Madison, Wis.: Dembar Educational Research Services, Inc., 1968. pp. 44-48.

Brown, Joseph C., et al. *Champion Arithmetics*. Stepped-Up edition. Evanston, Ill.: Row, Peterson & Co., 1937.

Brownell, William A. "Psychological Considerations in the Learning and the Teaching of Arithmetic," *The Teaching of Arithmetic*. Tenth Yearbook of the National Council of Teachers of Mathematics. Washington, D. C.: NCTM, 1935. pp. 1-31.

Brudner, Harvey J. "Computer-Managed Instruction," *Individualizing Instruction in Science and Mathematics*, ed. Virgil M. Howes. New York: The Macmillan Co., 1970.

Brueckner, Leo J. "A Critique of the Yearbook." Twenty-ninth Yearbook of the National Society for the Study of Education. Bloomington, Ill.: Public School Publishing Co., 1930. pp. 681-709.

________, and Foster E. Grossnickle. *Making Arithmetic Meaningful*. Philadelphia: The John C. Winston Co., 1953.

Gillet, Harry O., et al. *Washburne Individual Arithmetic*, Book Eight: The Meaning of Fractions. New York: The World Book Co., 1930.

Grossnickle, Foster E., and John Reckzeh. *Discovering Meanings in Elementary School Mathematics*. 6th edition. New York: Holt, Rinehart and Winston, 1973.

Hall, Frank H. *Arithmetic; How to Teach It*, a monograph. New York: Werner School Book Co., 1900.

Hilgard, Ernest R., and Gordon H. Bower. "Tolman's Sign Learning," *Theories of Learning*. 3d ed. New York: Appleton-Century-Crofts, 1966. Chapter 7.

Hunnicutt, C. W., and W. J. Iverson, (eds.). *Research in the Three R's*. New York: Harper and Brothers, 1958.

Lee, J. Murray, and Dorris May Lee. The Child and His Curriculum. 2nd edition. New York: Appleton-Century-Crofts, 1950.

Piaget, Jean. "The Rules of the Game," The Moral Judgment of the Child. 1932.

Skemp, Richard R. The Psychology of Learning Mathematics. Middlesex, England: Penguin Books, Ltd., 1971.

Thurstone, L. J. Primary Mental Abilities. Chicago: University of Chicago Press, 1938.

Washburne, Carleton, et al. Washburne Individual Arithmetic, Book Five. New York: World Book Co., 1927.

________, and Sidney P. Marland, Jr. Winnetka--The History & Significance of an Educational Experiment. Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1963.

Wheeler, Raymond. "The New Psychology of Learning." Tenth Yearbook of the National Council of Teachers of Mathematics. Washington, D. C.: NCTM, 1935. pp. 233-250.

Wilhelms, Fred T. "The Curriculum and Individual Differences," Individualized Instruction. Sixty-first Yearbook of the National Society for the Study of Education. Chicago: University of Chicago Press, 1962.

B. PERIODICALS

Baker, Frank B. "Computer-Based Instructional Management Systems: A First Look," Review of Educational Research, Vol. 41, No. 1, February, 1971. pp. 51-70.

Brownell, William A. "A Critique of the Committee of Seven's Investigations on the Grade Placement of Arithmetic Topics," The Elementary School Journal, XXXVIII, March, 1938. pp. 495-508.

Fattu, N. A. "The Teacher and Educational Research," High School Journal. March, 1961. pp. 194-203.

Flanagan, John C. "Functional Education for the Seventies," Phi Delta Kappan, September, 1967. pp. 27-32.

________. "Program for Learning in Accordance with Needs," Psychology in the Schools, 1969. pp. 133-136.

Grossnickle, Foster E. "An Experiment with Two Methods of Estimation of the Quotient," Elementary School Journal, XXXVII (May, 1937). pp. 668-677.

McKeachie, W. J. "The Decline and Fall of the Laws of Learning," Educational Researcher (A Publication of the American Educational Research Association) Vol. 3, No. 3, March, 1974. pp. 7-11.

Quirk, Thomas J. "The Student in Project PLAN: A Functioning Program of Individualized Education," Elementary School Journal, October, 1970. pp. 43-54.

Washburne, Carleton W. "The Individual System in Winnetka," Elementary School Journal, September, 1920. pp. 52-68.

C. REPORTS AND UNPUBLISHED WORKS

Beall, Ross H. "An Individual Instruction Unit in Long Division." Unpublished Doctor's dissertation, University of Iowa, 1932.

Behr, George, et al. "Managed Instruction with Computer Assistance." University of Wisconsin, 1972 (Mimeographed).

Flanagan, John C., et al. "The American High School Student." Final Report for Cooperative Research Project No. 635, U. S. Office of Education, Dept. of Health, Education, & Welfare, 1964.

Johnson, Lary, and Donald Ostrum. "Second Year Evaluation, Individually Prescribed Instruction (IPI) Mathematics Project," Hall School, Minneapolis Public Schools, Pub. date Oct. 1971.

Metter, H. L. "The Arithmetic Curriculum Since 1860." Unpublished Doctor's dissertation, University of Illinois, 1933.

Pigge, Fred I., et al. "Final Evaluation Report, Exemplary Middle School Mathematics," Bowling Green State University, Ohio, Office of Educational Research and Services: Galeon School System, Ohio, Publication date August, 1972.

Shanner, William M. "PLAN, A System of Individualized Instruction Utilizing Currently Available Instructional Materials." New York: Westinghouse Learning Corporation, 1968. (Mimeographed.)

Tack, Robert S. "The Effectiveness of the Westinghouse Learning Center Program Involving a Performance Contract on Reading and Mathematics Achievement of Educationally Deprived Children." Unpublished Doctor's dissertation, Brigham Young University, 1971.

Tewksbury, John L. "An Historical Study of the Winnetka Public Schools from 1919 to 1941," Volumes I, II, III. Unpublished Doctor's dissertation, Northwestern University, 1962.

"Goals for Americans." Report of the President's Commission on National Goals. The American Assembly, Columbia University, 1960.